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A RECORD OF PROGRESS RELATING TO AGRICULTURAL, MINERAL AND OTHER INDUSTRIES, WITH SPECIAL REFERENCE TO THE UTILISATION OF THE RAW MATERIALS OF THE DOMINIONS, INDIA AND THE COLONIES

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PLANT AND ANIMAL PRODUCTS

ARTICLES

WAR TIME DRUG SUPPLIES AND EMPIRE PRODUCTION
PART I

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Introduction

By far the greater part of Britain's requirements of plant drugs and medicinal herbs was formerly imported from overseas, our home production being relatively very small. A number of these imported drugs, including some of vital importance, came from the Continent, and with the outbreak of war and occupation by the enemy of various European countries our supplies were at once cut off. With others coming from overseas, although from sources still accessible to us, the need for conserving foreign currency and the difficulties of shipping-space, have made a drastic curtailment of imports necessary. In this sudden interruption of drug supplies we have a serious problem to deal with, and as in the case of food supplies the solution is twofold. In the first place the situation must be met with rigid economy in the use of drugs, especially those "key drugs" which we could not afford to be without. Secondly, so far as possible, production at home and in the Empire must be organised and expanded until sufficient to meet our requirements. Unlike the case of food supplies, the actual bulk of drug shipments is relatively small, so that if foreign exchange can be saved by production in Empire countries, importation should be possible on a limited scale. Economy in consumption alone is no cure, but it will tide us over until home and Empire supplies are forthcoming, and allow of a reduction of imports to a minimum.

A considerable measure of economy in the use of drugs is possible without any threat to the fulfilment of therapeutic requirements. Important drugs are often used for purposes for which they are not essential. Others in fairly common use, such as taraxacum or balsam of tolu, are not really necessary, and we should scarcely suffer from being deprived of them altogether. Restrictions are clearly possible in such cases. In many other cases there are substitutes which may be more readily available. For example, digitalis may be used instead of strophanthus in time of shortage, stramonium can replace lobelia, and filix-mas can replace cusso. The great importance also of chemical substitutes must be emphasised. Happily our chemical industry is in a far better position than it was in 1914 and supplies of necessary medicinal chemicals are being well maintained. As a result, chemicals manufactured in this country are available as substitutes for a number of drugs normally imported from overseas. Thus benzocaine may be used to replace aconite for external use, while sulphanilamide, hexamine or mandelic acid will serve as substitutes for such drugs as buchu, copaiba and cubebs.

This question of economy in the use of drugs has been examined by the Therapeutic Requirements Committee of the Medical Research Council. The Committee's recommendations regarding restrictions and the use of substitues have recently been published as *M.R.C. War Memorandum* No. 3, "Economy in the Use of Drugs in War-time" (H.M. Stationery Office; price 3d.), and in addition a National War-time Formulary is to be published shortly.

Even with the most rigid economy in consumption, supplies on a restricted scale must be maintained, and there are a number of drugs of vital importance for which the need may be greater than ever in war-time. Production of such drugs either at home or in the Empire is a matter of urgency. The cultivation in this country of sufficient belladonna, digitalis, hyoscyamus and stramonium to meet immediate needs has already been organised by the Government, and where possible steps have doubtless been taken to build up stocks of valuable drugs imported from foreign sources. These are in the nature of emergency measures, however, and in order to ensure adequate supplies in the future home production must be further increased where possible and cultivation established in Empire countries.

This question too has received the consideration of the Therapeutic Requirements Committee, and the Memorandum referred to above contains a list of drugs the production of which the Committee recommends should be encouraged in Great Britain and the Empire. The list is fairly extensive and includes, besides drugs that could be brought into production rapidly, a number, as, for example, those derived from trees and shrubs, which under cultivation would give no harvest for several years. From this it seems clear that the Committee has in mind not only the problem of immediate

war-time supplies, but also a long-term policy for encouraging the development of permanent Empire sources. Such a policy immediately raises the question of post-war markets, particularly in the case of what we may call the " long-term " crops, i.e. those requiring a number of years to come into production. Furthermore, the experimental work involved in introducing these crops into cultivation in a new country is often very considerable and far more than the private grower could be expected to undertake. It is here that the official aid of the Agricultural Departments is most needed. In a few instances the problem may be simplified by the existence of suitable unexploited material growing wild in some part of the Empire, when collecting and grading may be organised in a relatively short time. From the market point of view such cases resemble that of the " short-term " crop (annual and perennial herbs, etc.), where the grower can come into production within a short space of time and be of material assistance to the Empire's war effort. He will have the satisfaction of making this contribution in a time of need, and his market will be assured for the duration of the war, although perhaps subject to some limitation through shipping difficulties. The same question of post-war markets remains, however, for with the return of peace the grower must expect a return of competition from the original pre-war sources—competition from low-priced drugs collected from plants growing wild, and in some cases a flooding of the market with surplus stocks accumulated during the war. Coming just when production is getting into stride this renewed competition could easily prove overwhelming and some form of Government protection may be necessary for certain drugs if Empire cultivation is to be maintained.

In this connection it is worth while reviewing the possible advantages of having established sources of supply within the Empire. At the moment we are almost entirely dependent on foreign countries, in some cases on a single foreign source, for supplies of a number of the important drugs. The advantage of having adequate Empire sources of such materials as camphor, turpentine and menthol is too obvious under present conditions to require emphasis. This strategic advantage is clearly of greater importance with the long-term drugs than with herb crops. With the latter, the case for Empire cultivation must still be governed first and foremost by the cost of production and the quality attained. Any attempt to replace all imports from foreign countries by Empire production irrespective of cost and quality would obviously be a mistaken policy.

Many of the drugs imported prior to the war, especially supplies from the Continent, were gathered from plants growing wild in the woods and meadows. Collection and drying were spare-time occupations for peasant families, and the cost of production was consequently very low. Even with their exemption from the

10 per cent. import duty to which many drugs are subject, Empire supplies from cultivated plants could hardly compete in the matter of price. The question remains as to whether the higher costs from cultivation and freight can be set off by a higher quality of product. The answer to this must vary with different drugs, for although cultivation gives bigger plants, as a rule, with some crops the changed conditions may result in a lower content of active principle. With others, however, selection will sometimes yield a stock with a content of active principle far higher than that of the wild plant. Harvesting at the optimum time can be carried out more readily than in the case of scattered wild plants, and better drying facilities are usually available where the plants are cultivated. With these advantages, cultivation can with many crops give a product of higher quality, and above all of more reliable and even quality than the wild-grown drug. The trade should be prepared to pay some premium for this higher quality, once it is established, and if the grower can keep his expenses down to a reasonable level, there is hope that he will be able to retain his market.

The object of the present article is to assist the Empire grower setting out on the production of drug crops by giving, in collected form, information on their cultivation, harvesting and preparation for the market. The fostering of such production in British overseas countries and the examination and market evaluation of samples sent in by growers have been a definite part of the Imperial Institute's work for many years. This may now help to implement the recommendations made in the Medical Research Council's Memorandum (see p. 2) to encourage production in the Empire of certain specified drugs. Not all of these have been included in the discussion which follows, for, as already mentioned, the list is a fairly extensive one. In making the selection two main guiding factors have been taken into account as each drug was considered: the need for an Empire source and the practicability of establishing one. Questions relating to the advantages of having Empire sources of different drugs have already been reviewed. With regard to the second factor, it seems desirable where possible to confine production efforts to countries where the plants are already growing, either wild or cultivated. The introduction of a drug crop into a new country is always apt to be a long job and a matter of speculation, for, as already mentioned, even if the plant grows well in its new habitat the yield of active principle may be affected by some small climatic difference. Furthermore, if successful, introductions into a number of countries may easily result in over-production and so prevent any industry becoming established. It is here that the need for co-operation and careful planning must be emphasized. The value of previous cultivation trials, even if only on a small scale, is self-evident, and it is largely on this account that certain countries suggest themselves as sources for many of the drugs discussed. The East African colonies, for example, with

their need for cash crops, have for a number of years been particularly interested in the production of drugs and essential oils, and much valuable experimental work has been done, both by Agricultural Departments and by private individuals. The flourishing pyrethrum industry in Kenya, which has developed during the last thirteen years provides an impressive example of the fruits that such experimental work can bear. In the Seychelles Islands the distillation of essential oils has become a speciality [1], and new crops are constantly being tried out.

Before embarking on details of cultivation and preparation, which will form the subject of Part II of this paper, it has been decided to run through the list of drugs selected, giving brief notes on the pre-war sources of supply and the most likely countries for production within the Empire.

Notes on Pre-war Sources of Supply and Possibilities of Empire Production

Flowers

Chamomile.—The demand for chamomile flowers for pharmaceutical purposes is not large, but considerable quantities are used in toilet preparations, principally for hair shampoos. Nearly the whole of our supplies before the war came from Belgium, a small amount being grown in this country. The Belgian chamomile, which is derived from cultivated plants of *Anthemis nobilis*, a perennial, is of excellent quality and very white in appearance, thus setting a high standard.

Chamomile has been grown successfully on an experimental scale in the highlands of Kenya. Samples of the flowers sent to the Imperial Institute in 1936 were not so white as the Belgian product, but with experience in drying and preparation this could doubtless be remedied.

Santonica (Wormseed).—This drug, which is the commercial source of santonin, consists of the unexpanded flower-heads of certain species of *Artemisia*, principally *A. cina*. Supplies have come mainly from Turkestan, and are collected from wild plants. There is also some production in Kashmir from *A. brevifolia* (sometimes regarded as a variety of *A. maritima*), although this material contains less santonin than the Turkestan product [2]. Nevertheless we have in it an Empire source which could be developed.

The genus *Artemisia* has a very wide geographical distribution in Europe, Asia, North America and Africa, but the plants richest in santonin seem to favour regions of poor saline soils and semi-arid climate. Species occurring in the British Isles (*A. maritima* and *A. gallica*) have been examined at the Imperial Institute but proved to contain insufficient santonin to be worth extraction on a commercial scale [3].

Cultivation in East Africa has often been suggested, but so far this does not appear to have been attempted on any scale.

Fruits and Seeds

Caraway.—Like the related drugs dill and fennel, caraway is not used in any great quantity in pharmacy. It is, however, in demand for culinary use on a sufficiently large scale to warrant the encouragement of cultivation in the Empire. Our pre-war source of supply was the Continent, the bulk of the material coming from Holland and Germany, where the plant is cultivated.

The plant requires a cool temperate climate and is known to grow in East Africa.

Psyllium.—The "black psyllium" of the trade (derived mainly from *Plantago psyllium*) is produced in western Mediterranean countries, and especially in the south of France, which up till 1940 supplied most of our requirements. With this source now closed the place of black psyllium may largely be taken by ispaghula or "blonde psyllium" (*Plantago ovata*) from India. Black psyllium is preferred by the trade, however, and commands a far higher price than the Indian drug.

Black psyllium has been grown experimentally in Cyprus, and samples of the seed were submitted to the Imperial Institute for examination in 1932 and 1934. From the results of the examinations it is clear that Cyprus can produce seed in every way equal to the commercial French psyllium, but as the market at that time was unfavourable no further developments took place. Cultivation in East Africa has often been suggested and small-scale trials have probably been carried out. The plant has also been introduced into South Australia, where it was feared some years ago that it might become a troublesome weed. *Plantago arenaria*, which furnishes some of the black psyllium of commerce, grows locally in Great Britain, and production might be undertaken as a temporary measure.

The value of the seed depends on the mucilage which is contained in the husk, and it may be mentioned that in India the husks are sometimes sold separately.

Barks

Cascara.—Cascara bark is collected from a small shrubby tree, *Rhamnus purshiana*, native of western North America. Commercial supplies come from the Pacific Coast States of the U.S.A., and in increasing quantity from British Columbia. The bark is usually shipped freshly dried, but must be stored for at least one year before use. In consequence of this and of the time taken for the tree to come into production, experimental work with the cultivation of this crop is very slow to yield results. The plant has, however, been successfully introduced into Kenya [4, 5], and samples have proved to contain a satisfactory percentage of water-soluble extractive matter although the amount of ash exceeds the limit set by the British Pharmacopoeia. Clinical tests with liquid extract made from the Kenya bark in comparison with extract made from

the normal North American bark, showed the Kenya material to be satisfactory, although its therapeutic activity was slightly less [6].

Rhamnus purshiana has been grown on a small scale in Great Britain, under the aegis of the Royal Botanic Gardens, Kew. A sample of this bark examined recently at the Imperial Institute proved satisfactory as regards the percentages of aqueous extract and of ash, but the clinical tests cannot be made until the material has been kept for a year. Samples of bark from trees grown at Kew proved medicinally active in tests made a number of years ago [7]. The fact that the wood of this species has been found to yield a high-grade charcoal suitable for the manufacture of explosives may provide an added incentive to cultivation in this country.

Underground Structures

Calumba.—Calumba root (from *Jateorhiza palmata*) cannot be regarded as being of any special importance in pharmacy as its place can be taken by other bitter substances. Commercial supplies are derived from Portuguese East Africa, but the plant grows wild also in British East African colonies, and indeed there is already some export of the drug [8]. Production might be increased so far as shipping-space is available.

Colchicum.—Both the corm and the seeds of this plant (*Colchicum autumnale*) are valuable drugs. In the past supplies came almost entirely from the Continent, though small quantities of the plant occur wild in England (principally Herefordshire and Shropshire).

Parts of East Africa, India, New Zealand and possibly Australia should provide the cool temperate climatic conditions required by the plant, and although under cultivation it would be a few years before any harvest could be expected the possibility of establishing an Empire source seems worth considering.

Filix-mas.—This is another useful drug for supplies of which we have been largely dependent on the Continent. Most of the commercial material was collected from the forests of Germany. Small quantities have been collected in Great Britain, where the plant (*Aspidium filix-mas*) is not uncommon, and our production could be increased.

It seems unlikely that it would be worth while attempting to introduce the plant for cultivation, but, as it is reported to occur in the Himalayas, India is a possible source. Ferns are not always easily identified with certainty, so that great care must be taken to be sure of gathering the right species.

Glycyrrhiza.—The liquorice root of commerce is derived from species of *Glycyrrhiza* native of South Western Asia and Mediterranean countries. Production from wild plants is carried on in Southern U.S.S.R., Asia Minor and Persia, and cultivation is undertaken in Spain, France, Italy and Sicily. There is a very small production in England where the plant has been grown in the Pontefract district of Yorkshire since the sixteenth century.

Under cultivation it is three or four years before the roots can be harvested, but we already have a potential Empire source of the drug in Cyprus, where the plant occurs wild. Material from this colony submitted to the Imperial Institute in 1933 proved to be of good quality and was well reported on by the trade [9].

The plant is known to be grown also in parts of northern India.

Ipecacuanha.—Most of our pre-war supplies of ipecacuanha came from Brazil, where the plant is indigenous, growing in the forests. It has been introduced into the Federated Malay States, India and Ceylon, with varying degrees of success, for very careful cultivation and just the right degree of shading are necessary if the plants are to grow well. The present need for Empire supplies should give renewed impetus to experimental work and the development of production on a scale large enough to meet the demand.

Chinese Rhubarb.—This drug comes only from China and Tibet, where it grows at altitudes of up to 13,000 ft. Commercial supplies are obtained in part from cultivated material and in part from plants growing wild. The trade names of "Turkey Rhubarb" and "East India Rhubarb" refer in fact to Chinese material; they have their origin in the old trade routes overland by caravan to Constantinople or through India.

The plant has been cultivated in this country on a small scale for many years, but the English drug is inferior in quality to the Chinese and is not recognised by the British Pharmacopoeia. Species of *Rheum* with medicinal properties occur naturally in northern India, but *R. palmatum* and *R. officinale*, generally accepted as the source of the Chinese drug, appear to be absent. Their introduction and cultivation in the Himalayas might be attempted, though it is said to be six or seven years before a harvest is obtained. Parts of East Africa might also be suitable for the crop, and some interest has been shown in the possibility of growing it there.

Squill.—White squill (*Urginea scilla*) is produced in Mediterranean countries, Sicily being one of our main sources of supply before the war. We have in Malta, Cyprus and Palestine potential Empire sources ready to replace Sicily, for the plant occurs in all these countries. Samples recently sent to the Imperial Institute from Cyprus have had favourable reports from the trade, and with experience in drying there seems no reason why material of the highest quality should not be produced. Considerable quantities are also available in Egypt.

Owing to a recent shortage of white squill the use of Indian squill (*Urginea indica*) has been sanctioned by the British Pharmacopoeia. This plant is reported to grow wild in both East and West Africa, but the Indian production should prove sufficient, especially if our Mediterranean colonies can export the European squill.

Valerian.—Prior to the war supplies of valerian root (from *Valeriana officinalis*) were imported from the Continent, especially

from Holland and Belgium, to supplement our own production. The plant grows wild in England, but commercial supplies are from cultivated material.

With the loss of the Continental sources it would be desirable to increase the area under the crop in this country. Whether it would be advisable to introduce cultivation of the plant in Empire countries seems rather doubtful, especially as the use of Indian valerian (*Valeriana wallichii*) in official preparations is now sanctioned by the British Pharmacopoeia. It will doubtless be necessary to increase the output of this latter drug to meet our requirements, but as the plant is widely distributed in the Himalayas this should be possible.

Leaves, Herbs and Flowering Tops, etc.

Coca.—Coca leaves are obtained from *Erythroxylum coca* (Bolivian coca) and *E. truxillense* (Truxillo leaves), both shrubby plants native to South America. Commercial supplies come entirely from Peru, Bolivia and the Netherlands East Indies, where *E. truxillense* has been introduced into cultivation. A small part of the South American production is derived from plants growing wild.

At present there is no production of coca in the Empire. The plant was formerly introduced into a number of British countries, including Ceylon, India, Federated Malay States, and East and West Africa, but cultivation was discontinued in order to prevent abuse of the drug by the local native populations. In many Empire countries production is now prohibited except under special licence.

It will be seen from this that the question of renewed Empire cultivation of this drug is a matter for official decision. From the agricultural point of view there does not appear to be any special difficulty in the way of production; indeed the demand is so strictly limited that the risk of overstocking the market must be kept in mind.

Digitalis.—As already mentioned, the Government has organised the cultivation in this country of sufficient digitalis to meet immediate requirements. This home production needs to be supplemented by supplies from Empire countries if the loss of the Continental sources is to be offset completely.

In parts of India, especially Kashmir and the Nilghiri Hills, *Digitalis purpurea* has been introduced and is cultivated chiefly as an ornamental plant. The plant occurs also in New Zealand, where it has become naturalised and is reported to be abundant in some areas. The possibilities of commercial production of the drug from this source are now under consideration.

Besides the dried leaves of *Digitalis purpurea*, which is the only species recognised by the British Pharmacopoeia, there is a market also for *D. lanata* and *D. lutea* leaves, which must of course be designated as such and not mixed with the official drug. The

seeds of digitalis are also collected for extraction of the glycosides which they contain.

Ephedra.—Commercial supplies of ephedra herb are derived almost entirely from China. There was formerly a small production in Spain, but this was interrupted by the civil war. Chinese supplies also have been very uncertain as a result of the Eastern conflict, with times of scarcity when the prices have reached three or four times their normal level. This has brought on to the market a synthetic ephedrine, but the cost of production is such that it cannot compete with the natural product under normal conditions.

In India there are species of *Ephedra* growing at high altitudes in the mountains of Baluchistan and the Himalayas. A study of these plants published by Krishna and Ghose in 1930 [10] showed that two species, *E. nebrodensis* and *E. gerardiana*, may yield material as rich in ephedrine as the best Chinese herb, which is largely derived from *E. sinica*. Irregularities in the Chinese supplies during 1937 stimulated production from this source, and in the following year nearly 450,000 lb. were shipped to the United States, the principal consumer. Since that time America has been able to get regular supplies from China again and Indian shipments have ceased. It is understood that in bulk the quality of the Indian material was somewhat erratic. This may be due in part to variability of the individual plants ; it is more probably accounted for by the indiscriminate gathering of active and inactive species. Further study of the geographical distribution of the different species and the best time and season for harvesting should help to overcome these difficulties, and a useful industry may be established.

Other species of *Ephedra* occur in some Mediterranean countries, and following a note in this BULLETIN [11] samples of *E. altissima* from Malta and *E. fragilis* from Cyprus were submitted to the Imperial Institute for examination. Neither of these proved to be of any commercial value.

The possibility of cultivating the Chinese species in Kenya has been considered, and trials with material supplied by Kew were undertaken in 1938, but so far news of their progress is lacking.

Hyoscyamus muticus.—This drug, known as Egyptian henbane, is not official, but is largely used for the extraction of hyoscyamine. Commercial supplies, consisting of the dried leaves of the herb, come mainly from Egypt, but the plant occurs also, either wild or naturalised, in India, the Anglo-Egyptian Sudan and Uganda.

Lobelia.—This is derived from an annual herb, *L. inflata*, indigenous to the eastern United States and Canada. For the official drug both the leaves and flowering tops are taken, supplies coming in part from wild and in part from cultivated plants.

The United States is the principal producing country. Canada's output is relatively small but could doubtless be expanded. It has been suggested also that lobelia might be cultivated in East Africa.

Essential Oils and Allied Drugs

This group presents production problems of a rather different nature from those of the crops already discussed, where the crude drug is the final product as far as the grower is concerned. With essential oil crops the distillation of the oil takes place as a rule on the scene of production, and generally from the freshly harvested plants. Dried material may in some cases be used, thus permitting a spread of the distilling period, but there is loss of oil in the drying and storage resulting in a lowering of the final yield. The British Pharmacopoeia requires that official oil of chenopodium and oil of peppermint must be distilled from the freshly gathered herbs. Thus a considerable outlay is involved to provide the necessary distilling plant, the details of which vary somewhat according to the oil which is to be produced.

The general technique of preparation is by steam distillation which enables the oil to be removed without employing a very high temperature. For this purpose a good supply of fresh water is needed. The modern still is a steam-jacketed vessel with a wire basket in which the charge is held well above the bottom of the still. After preliminary heating steam is blown into the vessel, and the volatile oil is thus driven off from the plant material and passes over as a vapour mixed with steam to the condenser. The condensed oil and water separate out in the receiving vessel where the oil can be drawn off from the top or bottom according to whether it is lighter or heavier than water. The water usually contains a small proportion of oil in solution or emulsion, and is generally returned to the still so that only a relatively small amount is kept circulating, and the loss of oil through this cause is reduced.

Oils sometimes need further rectification by distillation or other means, but this can normally be carried out in the importing country.

Other methods than distillation are used in some cases to obtain the oils, as, for example, with lemon oil which is obtained by rupturing the oil cells of the peel by pressure or scarification. The latter process is known as ecuelling.

Oil of Chenopodium.—Although the demand for chenopodium oil in Great Britain is limited, the requirements of Empire countries, especially those in the tropics, are considerable. Commercial supplies of the oil, which is distilled from *Chenopodium ambrosioides* var. *anthelminticum*, come from the United States.

The plant is widely distributed in North and Central America and the West Indies and is reported as a common weed in many parts of Africa. It is not known whether the local African strains will give a good yield of oil, but small-scale cultivation trials with introduced material have in some instances been promising. There has not so far been any commercial production. A sample of the oil submitted by Mauritius in 1926 [12] did not fully satisfy British

Pharmacopoeia requirements, but this was probably due to deterioration in quality between the times of distillation and examination.

The distillation of the oil is attended by certain technical difficulties as it must be carried out rapidly under pressure, and a rather more elaborate plant is required than is the case with most essential oils. British Pharmacopoeia requirements specify that the oil shall contain not less than 65 per cent. by weight of ascaridole, and this substance is destroyed by slow distillation.

Peppermint Oil and Menthol.—Peppermint oil is produced for two main purposes: as a flavouring agent and as a source of menthol. The oils used for flavouring, which normally command the highest price, do not necessarily have a high menthol content (the British Pharmacopoeia specifies not less than 46 per cent. by weight). The demand now, however, is rather for oil that will provide a source of menthol.

Most of the good-quality flavouring oil is produced in the eastern United States from varieties of *Mentha piperita.* There is a limited production of very high-grade oil in England, and a small quantity has been distilled in Western Australia. Japan is about the sole producer of the high menthol oil, which is derived from *Mentha arvensis.* A part of the menthol separates out readily on cooling the oil by means of ice and salt mixtures. This is removed by filtration and shipped separately while the remaining " dementholised " oil (which still contains some menthol) is sold as a cheap flavouring oil. This is the Japanese peppermint oil of commerce. The possibilities of large-scale production within the Empire have received a good deal of attention, especially in East Africa and the Seychelles Islands, but there have so far been no commercial developments in these countries. Oils produced on an experimental scale in East Africa have been of the type used for flavouring purposes, and some samples have shown great promise. The appearance of mint rust disease, however, has been a serious obstacle in the way of developing the industry. Under East African conditions, where there is no proper dormant period for the plants, the disease is proving extremely difficult to check. The Seychelles, on the other hand, have produced *Mentha arvensis* oil of very high menthol content [13]. This may well prove a valuable source of natural menthol.

Menthol is also produced synthetically.

Thymol.—Commercial supplies of this valuable antiseptic were formerly derived almost entirely from Indian ajowan seed (*Carum copticum = Trachyspermum ammi*). Prior to 1914 most of the Indian crop, which was very considerable, was exported to Germany, where the thymol was prepared. During the last war a factory was started for production in India, but this only operated for a few years [14]. Since that time the industry has been practically killed by competition from German synthetic thymol, and cultivation of ajowan in India is now only on a very small scale. With

the German competition now removed production in India might be re-developed. Ajowan has been grown experimentally also in the Seychelles Islands and Montserrat [15], and seed from the former source examined at the Imperial Institute proved to yield about twice as much thymol as the average Indian material.

Thymol can be obtained from a number of other sources, notably oil of thyme (*Thymus vulgaris*) and oils from certain species of *Ocimum* and *Monarda stricta*. Of these the ocimum oils are of greatest interest from the point of view of possible Empire production. *O. gratissimum* and *O. viride* both yield oils sometimes with a high content of thymol, and have been cultivated experimentally in the Seychelles. Samples of *O. gratissimum* oil from this source examined at the Imperial Institute [16, 17] did not appear promising, but oil of *O. viride* from the Seychelles and Sierra Leone [18, 19, 20] proved to contain from 31 to 62 per cent. thymol, thus providing a valuable potential source.

Commercial oil of thyme is produced mainly in Spain and France. A trial distillation from the native thyme of Cyprus [21] yielded 36·5 per cent. thymol. The possible utilisation as an antiseptic of the chemically allied substance carvacrol from Cyprus origanum oil might also be considered.

Synthetic thymol is manufactured from piperitone which in turn is a constituent of some Australian eucalyptus oils and of the oil from an Indian grass, *Andropogon jwarancusa* [14].

Camphor.—Production of natural camphor is, practically speaking, a Japanese monopoly, while most of the synthetic camphor, which is made from turpentine, has in the past been manufactured in Germany. There is a small output of the synthetic product in Great Britain, but not nearly enough to satisfy our normal requirements.

The Japanese camphor oil is mostly obtained by steam distillation of the wood of mature wild trees, usually over 50 years old, the solid camphor separating out when the oil is cooled. Camphor trees have been grown experimentally in many parts of the Empire, including India, Burma, Ceylon, Malaya, the West Indies and East Africa, with a view to producing camphor from the oil distilled from the leaves and twigs of younger trees. Although the trees have made satisfactory growth in most cases, the results have been disappointing, and there has been no commercial development. It seems that the production of camphor by distillation of the leaves and twigs cannot be carried on economically in competition with the Japanese production from the wood of the tree. One reason for this lies in the fact that after removal of the camphor the oil derived from the wood is still valuable on account of the saffrol which it contains, this substance being absent from the leaf-oil. In view of these results and the additional competition from synthetic camphor further attempts at Empire cultivation have been abandoned. Whether under present conditions it would be

worth while reconsidering the question seems doubtful. An expansion of the manufacture of synthetic camphor might be a more profitable course to follow, but this in turn would depend on supplies of turpentine.

There is another possible source of camphor in the oil distilled from the leaves of certain species of *Ocimum* or camphor basil, notably *O. kilimandscharicum* and *O. canum*. The latter species has been cultivated on a fairly extensive scale in the southern U.S.S.R., where it is stated that 20 tons of medicinal camphor were produced in 1936 [22]. Both plants are perennial herbs and are widely distributed in East Africa and the Anglo-Egyptian Sudan. Samples of the oil examined at the Imperial Institute have varied widely in their content of camphor, the most satisfactory, which was from *O. kilimandscharicum* grown in the Sudan, containing about 70 per cent. Climatic conditions and time of harvesting doubtless play a part in determining this figure, but so far little is known of the nature of their influence. The results have at any rate been sufficiently promising to justify trials on a larger scale, which, if successful, might lead to the development of an Empire source of camphor.

Oil of Turpentine.—This product may be derived from several different species of *Pinus*. The thick oleo-resin is first obtained by tapping the bark of the trees; it is then distilled to separate the volatile oil of turpentine from the resinous portion, which is known as colophony. The oil of turpentine is rectified by further distillation with water and potassium carbonate, giving the final official product.

Practically all the world's supplies of oil of turpentine come from either the United States, where it is derived mostly from *Pinus palustris*, or France, where *Pinus pinaster* (=*P. maritima*) is the source. Production within the Empire is so far limited to India where there is a moderate output from "Chir" pine (*P. longifolia*). Although satisfactory for use in the paint and varnish industries, the oil from this tree differs in composition from the French and American oils and would scarcely be suitable for medicinal purposes. The difference lies in the lower content of the constituent α-pinene in the *P. longifolia* oil (less than 25 per cent. as compared with 60 to 70 per cent. in the French and American oils). This is of especial importance as it makes the Indian oil unsuitable also for the economic manufacture of synthetic camphor, for which purpose an α-pinene content of at least 60 per cent. is necessary.

India has, however, potential sources of oil with a very high pinene content in two native species, *Pinus excelsa* and *P. khasya*. It appears that the areas occupied by these species are small and no commercial supplies of the oils have become available.

Other possible sources of oil of turpentine within the Empire are Cyprus, Australasia and British Honduras. In Cyprus the

tapping of *P. halepensis* has long been under consideration [23, 24], while Australia and New Zealand have planned production from certain introduced species, but none of this work can be said to have passed the experimental stage. In British Honduras there are forests of *P. caribaea*, a species from which some of the American oil is derived. Preliminary tapping experiments made a number of years ago gave promising results, but further work is needed before any reliable estimate can be made of the commercial possibilities of this source.

Gums and Seaweed Products

Gum Tragacanth.—This commodity is obtained from species of *Astragalus*, low thorny shrubs growing in the mountainous regions from Asia Minor through Syria and Kurdistan to Iraq and Iran. Formerly commercial supplies came from Asia Minor where *Astragalus gummifer* is the principal source.

For the official drug the British Pharmacopoeia now specifies Persian tragacanth, which is derived from several different species growing in Iran, Iraq and Kurdistan. Trease [25] lists ten gum-yielding species that are known to grow in the area where the Persian tragacanth is collected. These are *A. gummifer* Lab., *A. kurdicus* Boiss., *A. brachycalyx* Fischer, *A. eriostylus* Boiss. and Haussk., *A. pycnocladus* Boiss. and Haussk., *A. verus* Olivier, *A. leioclados* Boiss., *A. adscendens* Boiss. and Haussk., *A. strobiliferus* Royle and *A. heratensis* Bunge. Most of the gum is obtained from plants growing between 4,000 and 10,000 ft.

In order to obtain the gum, according to Trease, the plants are incised at the base of the stem and there follows a considerable exudation from the wound. The dried exudate is collected some two days later and is graded and marketed without further treatment. Sometimes the plants are burned at the top to increase the flow of gum, but this treatment is said to have an adverse effect on the quality. The plants should be two years old before they are tapped.

The most likely areas for Empire production would be in Baluchistan and the North-West Frontier Province of India, where conditions most nearly resemble those in Iran and Kurdistan. Possibly there are gum-yielding species of *Astragalus* already growing in this region.

It has recently been suggested that cultivation of the plant might be attempted in Rhodesia if a supply of seed can be obtained. The yield and quality of products of this type are, however, so profoundly influenced by slight climatic variations that the outcome of trials in new areas must remain a matter for speculation.

For some purposes gum tragacanth can be replaced by Indian karaya gum, derived mainly from *Sterculia urens*, but this is not recognised by the British Pharmacopoeia.

Irish Moss and Agar-Agar.—These are both obtained from

seaweeds of the large botanical group, the red algæ. In the case of Irish Moss, prepared from *Chondrus crispus*, the most obvious course is to encourage larger production in Ireland.

Species of the genus *Gelidium* and to a lesser extent of *Gracilaria* and *Euchema* form the source of Japanese agar-agar, which makes up practically the whole of the world's commercial supplies. In recent years small industries have been developed using seaweeds from the coasts of Southern California [26], Java and the shores of the Black Sea. There is no commercial production within the Empire.

A form of agar-agar is prepared by the Chinese in Malaya from seaweeds collected locally. The algal flora in these waters naturally differs in its species from that of the temperate seas of Japan, but a number of samples of *Gracilaria lichenoides* from Malaya examined recently at the Imperial Institute appeared promising as a possible source of agar-agar. Preliminary reports, however, indicate that the material is not present in sufficient quantity for commercial production.

The presence in New Zealand waters of considerable quantities of seaweeds suitable for the manufacture of agar-agar has recently been reported. So far samples have not reached this country for examination, but should the material prove satisfactory this might provide a solution to the problem of Empire supplies. Other possible sources within the Empire are Ceylon, Hong Kong, Seychelles and the Falkland Islands, and inquiries have been made as to the quantities of likely seaweeds that might be available. It can still be said, however, that the information on this latter point is far from complete and the possibilities of obtaining the materials from deeper waters below tide level (about 3 to 5 fathoms) might be more fully explored. Mention may be made of a sample of *Gracilaria wrightii* var. *zeylanica* from the Seychelles examined at the Imperial Institute in 1927 [27] which was found to be comparable with the finest grades of Irish moss. Agar-agar manufacture in warm countries such as Malaya or Ceylon would require the installation of a refrigerating plant, as the material is purified by freezing.

Cultivation of seaweeds is carried out in parts of Japan, but it is really no more than an encouragement of the growth in a certain area of naturally occurring seaweeds by providing favourable conditions of currents, anchorage, etc. In order to achieve any useful results the biology of the species concerned must be thoroughly studied and understood.

Although in some of its industrial applications agar-agar can be replaced by algin products manufactured from seaweeds in this country, there is no real substitute for the material in bacteriological work.

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INSECT INFESTATION OF CACAO BEANS IN THE PRODUCING COUNTRIES

WITH A NOTE ON THE EXTENT TO WHICH *EPHESTIA ELUTELLA* HUB. AND *E. CAUTELLA* WLK. ESTABLISH THEMSELVES IN WAREHOUSES AND FACTORIES IN GREAT BRITAIN

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The following is an account of some investigations carried out between 1936 and 1939 into the sources and development of insect infestation of cacao beans.

It may serve to supplement the publications of Cotterell and others on the infestation of cacao beans in the tropics. It does not deal with attack by insects in this country, although a note on the distribution of *E. elutella* and *E. cautella* in warehouses and factories is included.

The main interest at the inception of this work was to obtain definite proof as to where infestation first occurs and a scheme of research was drawn up by the Insect Infestation Sub-Committee of the Manufacturing Confectioners' Alliance. This Committee consisted of Sir Francis Terry, the late Mr. A. W. Knapp and Mr. T. Macara.

In the first instance series of samples were obtained from the Gold Coast, Trinidad and Venezuela, the necessary arrangements being made by Messrs. Cadbury Bros., Ltd., and Messrs. Joseph Terry & Sons, Ltd.

The scheme was then submitted to Sir Frank Stockdale, at that time Agricultural Adviser to the Secretary of State for the Colonies, and was, after some modification, forwarded by him to the Governments of various British cacao-producing colonies. The Research Association also communicated with the authorities of non-British countries and one series of samples was obtained from Brazil. The thanks of the Association are due to these authorities as well as to the Departments of Agriculture of Ceylon, the Gold Coast and Grenada for their co-operation and the provision of the necessary samples.

Scheme of Research

The following passages are taken from the scheme as finally approved, certain details as to methods of labelling samples being omitted as unnecessary for the purpose of the present Report.

Research on Infestation of Cacao

Preliminary Notes.—" The object of the scheme of research is to ascertain the points at which infestation of beans occurs.

" Beans with cracked shells, or which have germinated, thus being liable to become infested, are selected from the drying platform or from a number of drying platforms and placed in a special bag. Before the bag is closed and labelled the beans should be well mixed and a 7 lb. sample withdrawn and placed in a special tin supplied. Two of the labels also supplied are filled in with details as to the country of origin, place at which the sample was taken, date and so on. One label is placed inside the tin and the other is fastened to the top. The bag is then labelled (one label inside the bag and one outside) and closed in the usual manner and sent to this country through the usual channels, further samples being withdrawn at intervals as suggested below.

" It would be more satisfactory if the beans in the bag could be sterilised by being heated up to a temperature of, say, 150° F. after each sample had been drawn so that if infestation is found in the samples after some weeks storage it would be certain where it had occurred. The difficulties involved in this procedure are probably too great to make it practicable, and we hesitate to suggest it. If in any series of samples such a process is practicable, it is hoped that those responsible for collecting samples will adopt it; noting the fact, of course, on the labels. It is essential that the beans should actually attain 150° F. as indicated by a thermometer inserted in the bulk. It is not sufficient merely to subject them to air at a temperature of 150° F.

" Fumigation might impart a temporary repellent property to the beans and thus render the experiments unsatisfactory and is therefore not recommended for these samples.

" It is important that each colony should keep its samples in series, each series of samples being obtained from one bag. These

series should be numbered, and the series number stated on the labels.

Method of Taking Samples.—" A bag of ' broken '—i.e., germinated, cracked shell and broken shell—beans should be selected from beans on a drying platform or from several drying platforms. This will entail a simple visual examination of a considerable quantity—possibly 10 cwt. of beans. A label giving the series number should be inserted in the bottom of the bag in case the outside label becomes detached.

" (*a*) These beans should be thoroughly mixed and a 7 lb. sample drawn from the bag and placed at once in one of the special tins. The bag, after the sample has been drawn, should then be closed and go through the usual procedure in the country of origin of the beans, 7 lb. samples being removed as follows :

(*b*) Upon receipt at an up-country store.

(*c*) After storage up-country—one month would be a suitable period.

(*d*) On arrival at port.

(*e*) After a stated period (say one month) at the port.

(*f*) When shipped, if kept more than one month at port.

" The various samples, together with the remainder of the bag, should be forwarded to these laboratories suitably labelled.

" It is hoped that each colony will find it possible to collect and forward up to say, four series of samples each marked with a distinguishing series number. The four or more series might well be spread over crops reaped during one year."

It should be noted, however, that in some instances the term " Drying Platform " must not be taken too literally. Small farmers and peasant producers of cacao dry their produce in a very primitive way and probably take it into the home, or hut, at intervals during the drying period. On estates, too, cacao may be in an estate store during part of the drying period, so that the occurrence of infestation in a sample drawn from the " Drying Platform " does not by any means make it certain that the attack took place in the open air.

Type of Bean Attacked

Wadsworth [1] has shown that whole undamaged beans are attacked by insects to a very slight extent whereas cracked and damaged beans form a readily available food supply. It was on this account that " broken " beans were stipulated in the research scheme. One result of this stipulation was that, in the majority of cases, a percentage infestation could not be assessed with any degree of accuracy.

Species of Moth Attacking Cacao

Owing to the great confusion which exists with regard to the identity of the moth or moths attacking cacao it was decided to

determine correctly, in as many cases as possible, the insects found throughout these investigations. The *Ephestia* species were separated by the genetalia method of Richards and Thomson [2] or by the wing venation where the body portions were lacking. With regard to the larvæ found, these have also been classified, but identifications of larvæ are not so specific as those of the adults.

It is interesting to examine the literature on this subject for Richards and Thomson [2] state (p. 188) that *E. elutella* has been so often misidentified that references to it in the literature are of little value. Generally speaking, it is added, *E. cautella* is usually correctly identified but references to *E. elutella* may be to either species.

It would seem that a practice has arisen of calling all *Ephestia* moths found on cacao *Ephestia elutella* probably because of the "common" name Cacao Moth which has been given to this species. Not only is such a practice unwise but it gives rise to unfortunate repercussions. For instance, it might be thought that if the moth infesting cacao in Britain is *E. elutella* then the cacao of West Africa, where the great majority of the *Ephestia* moths are *Ephestia cautella* (Nicol [3]), could not be a source of general infestation in Britain. Such a conclusion would be quite wrong as examinations of many moths caught in cacao warehouses and chocolate factories have shown (p. 24).

Examination of Special Samples

Preliminary Series from the Gold Coast, Trinidad and Venezuela

The results of the preliminary series of samples of beans drawn in the Gold Coast, Trinidad and Venezuela by arrangements made by Messrs. Cadbury Bros., Ltd., and Messrs. Joseph Terry & Sons, Ltd., are given in Table I.

Table I

Country of Origin.	Series Number.	First Occurrence of Ephestia spp. or Attack by Ephestia spp.		Species of Ephestia.
		Sample.	Stage.	
Gold Coast	1	1	Drying	*E. cautella.*
	2	1	"	
Trinidad	1	1	Drying	*E. cautella*
	2	1	"	
	3	1	"	
	4	2—3	Between Estate and Up-country Store	
Venezuela	1	1	Drying	*E. elutella*
	2	2	Estate Store	
	3	2	" "	
	4	2	" "	
	5	2—3	Between Estate and Port	

Series of Samples from the Gold Coast, Ceylon, Grenada and Brazil

The results of the subsequent series obtained through the Agricultural Adviser to the Secretary of State for the Colonies and from Brazil are given in Table II. The later Brazilian samples all arrived in a mouldy condition but the information obtained from the first sample was sufficient for the purposes of this Report.

Fernando [4] has given a very complete history and report on the cacao obtained from Ceylon for the purposes of these investigations.

TABLE II

Country of Origin.	Series Number.	First Occurrence of Ephestia spp. or Attack by Ephestia spp.		Species of Ephestia.
		Sample.	Stage.	
Gold Coast	1A	1	Drying	*E. cautella.*
	2A	1	,,	
	3	1	,,	
	4	2	Up-country Store (*a*)	
	5	4	Port (Accra)	
Ceylon	1	2	Estate Store	*E. elutella* and *E. cautella.*
	2	4	Port (Colombo)	
	3	2	Estate Store	
	4	3	Up-country Store	
Grenada	1	1	Drying	*E. cautella.*
	2	1	,,	
	3	1	,,	
Brazil	1	1	Up-country Store (*b*)	*E. elutella.*

(*a*) *First damage by Mussidia nigrivenella (see page 22) in Sample* 1 *(Drying Platform) and not by Ephestia spp.*
(*b*) *No sample was drawn on drying floor.*

These data show that in every case attack first occurred in the producing country and that in the majority of the samples the attack commenced at a very early stage in the production of the bean.

Although those in the producing countries were asked to obtain the beans initially from the drying platform or floor, this was not always possible especially in the Gold Coast, so that the stage termed " Drying " in Tables I and II may represent anything from the actual drying to the time when the beans were purchased from the native farmer.

INSECTS FOUND IN THE SPECIAL SAMPLES

Lepidoptera

Ephestia elutella Hb. *and cautella* Wlk.—It will be seen from Tables I and II, column 5, that *E. cautella* predominated in cacao from West Africa ; in fact, apart from a few unidentifiable specimens all moths in samples drawn in that country were *E. cautella.* On

the other hand, the majority of the moths obtained from the Central and South American countries were *E. elutella* with a small proportion of *E. cautella*.

This fact was discussed fully in the BULLETIN OF THE IMPERIAL INSTITUTE [3].

Corcyra cephalonica Staint.—This moth is not very common on cacao but it was found once or twice during the survey. The first instance was in Series 4 of the Venezuelan samples and, as a result, a descriptive note was published in the *Entomologist's Monthly Magazine* [5] containing a full description of all stages and also of the damage done by this moth. The damage is rather different from that of the *Ephestia* spp., and a brief description may be of value. The beans become matted together by the thick felty cocoons which are so characteristic of this moth and the frass is usually larger than that left by the *Ephestia* moths.

This moth was also found in Series 3 of the Gold Coast special samples and according to the Entomologist of the Gold Coast Department of Agriculture, this is the first record of the species there. In all probability it migrated from rice stored in its neighbourhood.

Mussidia nigrivenella Rag.—This species is unusual on cacao but it is recorded as feeding on maize on the Gold Coast. It was found in Series 4 from the Gold Coast.

The moth itself is rather similar to *Ephestia kühniella* Z., measuring about 1¼ in. across the expanded wings. The fore-wings are brown-grey with two well marked light coloured zig-zag lines; one about half way along and the other towards the tip. The hind wings have two very distinct lines running just inside their outer edge.

The larva, when fully grown, is plump, dirty white and measures about ¾ in. in length. It is similar to an *Ephestia* larva but it can be distinguished by its having on the front edge of each segment two irregular rows of minute pale brown spots.

The pupa is larger than either of the cacao infesting *Ephestia* species and is characterised by a very prominent ridge along the back.

Coleoptera

Aræcerus fasciculatus De G., Coffee weevil or Tephrosia beetle. Common in West Africa where it can infest the growing cacao pods. This beetle does not seem to persist in this country over winter, but it can cause a great deal of damage, in fact Cotterell [6] is of the opinion that this insect is equally as important as *Ephestia cautella* as a cacao pest on the Gold Coast.

Tribolium castaneum Herbst., the rust-red flour beetle, occurred fairly frequently but is probably of little importance.

Oryzæphilus surinamensis L., the saw-toothed grain beetle is of little importance in cacao.

Lasioderma serricorne Fab., the tobacco or cigarette beetle, can cause considerable damage to cacao and it was found at one time or another on samples from all countries except Ceylon.

Cathartus advena Waltl. Found in small numbers in Venezuelan, Nigerian and Ceylon samples. Usually attracted by mouldy foodstuffs.

Læmophloeus spp. Very small beetle usually feeding on moulds and of no importance.

Ptinus tectus Boield., a rubbish feeder of little importance.

Carpophilus dimidiatus F. Fairly common in small numbers but in the case of the Brazilian samples, where the beans were very mouldy, these beetles were found in large numbers and they created a great deal of damage, reducing many beans to powder. It is unlikely that these insects would attack sound cacao to any great extent, and they were probably attracted in the present instance by the mould.

Psocoptera

Several unidentified species were found. These minute insects are of no practical importance.

Hemiptera

Piezostethus flavipes, fairly common but of no importance, probably predacious on *Ephestia* spp.

Hymenoptera

Microbracon hebetor Say., predacious on *Ephestia* spp.

Bethylid, unidentified species predatory on *Lasioderma serricorne*.

This list contains several additions to that published by Passmore [7].

Insects found in Stores and Factories in Great Britain

Moths were collected from eight cacao warehouses (in London and Liverpool) and from three chocolate factories, and their species determined. The moths from Factory C were all trapped in one of the chocolate manufacturing rooms.

Table III

Place.	Percentage.	
	E. elutella.	E. cautella.
Factory A	38	62
Factory B	12	88
Factory C	0	100
Warehouses (6 in London)	88	12
Warehouses (2 in Liverpool)	47	53

It was found that in the cacao warehouses, although *E. elutella* predominated, there were also large numbers of *E. cautella*. In the factories, however, the tables were turned and the predominant species was *E. cautella*. Such a finding suggests that *E. cautella*, when feeding on cacao, is perhaps the less hardy species and can exist more readily in the warmer atmosphere of the factory.

Thus it would seem that *Ephestia cautella* is equally as important as *Ephestia elutella* as a pest of cacao in this country.

Summary

This survey has plainly shown that insect attack usually commences at a very early stage in the progress of the cacao beans from the growing areas to the coast.

In two series only out of twenty-five was the initial attack delayed until the cacao reached the port of shipment. In nineteen series of the twenty-five, attack first occurred on the estate premises.

The insects chiefly responsible for the damage are again shown to be *Ephestia elutella* and *E. cautella* and although other moths and beetles were found, they are not of much importance.

The majority of moths from West Africa are shown to be *E. cautella*, whereas the chief South American species is *E. elutella*. In this country *E. cautella* does not appear to be so widely distributed as *E. elutella*, but it is equally important as an infesting species.

Owing to the proportion of *E. cautella* being greater in factories than in cacao warehouses it is suggested that it is the less hardy species and its predominance in factories is due to the warmer conditions prevailing there.

Recommendations

(1) The greatest care is necessary in the maintenance of cleanliness and anti-moth precautions in all cacao stores, particularly those in the tropics. It is owing to attack in these places that cacao arrives in London with *Ephestia* spp. larvæ present in it.

(2) Damaged and germinated beans should be reduced to a minimum. It is such beans which are most open to attack by the *Ephestia* moths and other insects.

(3) Both *Ephestia cautella* and *E. elutella* can survive and propagate in this country. The above precautions should therefore be taken in all exporting countries.

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THE MANUFACTURE OF DRIED BANANA PRODUCTS

Two different types of products can be made by drying bananas, according to whether the fruit is taken "green" or ripe. In the latter case the starch has become converted into sugar, and it is at this stage that the fruit is dried to make dried bananas (banana figs) and banana flakes. In the unripe fruit the carbohydrates exist almost entirely as starch, and in this condition the fruit can be converted into banana flour.

I. Dried Bananas (Banana Figs)

For the manufacture of banana figs the fruits must be quite ripe. If they are dried before the whole of the starch has been converted into sugar they yield a hard product, lacking in sweetness and flavour. On the other hand if they are over-ripe the resulting figs will be sticky and discoloured, a condition the avoidance of which is, in any case, one of the chief difficulties in their manufacture.

Varieties.—The particular variety of banana used has some influence on the results obtained, but it is not likely that bananas would generally be planted especially with a view to the production of "figs," and in practice the greatest quantities of the latter found in the European market are made from Gros Michel and Cavendish bananas, the latter giving the better results.

In gathering the fruit, and in any subsequent storage prior to treatment, care must be taken to protect it from bruising.

Peeling.—The first stage in the treatment is to remove the skin, a process which can be facilitated if necessary by momentary immersion in boiling water. The peeled fruits can be dried whole, but it is more usual to divide them into two longitudinal sections. For this purpose knives made of bamboo or wood, or of stainless steel, can be employed; ordinary steel knives must not be used as they would discolour the product.

Drying.—There are various processes for drying the bananas. The simplest is sun-drying, and this is practised in some countries, the fruit being simply exposed in trays to the heat of the sun and covered at night and in cloudy weather. The drying takes several days. Not only is there uncertainty as to the degree of drying obtained by this method, but there is a risk of some acetic fermentation taking place, the appearance of the finished product is liable to vary considerably, and there is danger of contamination by insects and dust.

Artificial methods of drying are to be preferred if the product is intended for export. Good results can be obtained with a simple "drying closet," i.e. a room heated by a stove, provided there is adequate ventilation so that the moist air is rapidly removed and a steady current of air kept up. In order that the drying may be properly controlled it must be as regular as possible, the material in different parts of the chamber being treated equally. Especially to be avoided is any possibility of moisture being recondensed on to material in process of drying.

More elaborate equipment can be employed if the quantities to be treated make it worth while, and probably the most generally useful installation is some form of "tunnel" plant.

The tunnel system consists in the employment of a long chamber or tunnel which can be heated and in which provision is made for the conveyance of the material to be dried from one end of the tunnel to the other, generally by means of a series of carriers running on rails. The heating is effected by means of steam pipes, and a current of hot air is kept up by means of fans. The "counter current" principle is commonly employed, that is to say the air is forced along the tunnel in the opposite direction to that in which the material is travelling, by which means the latter encounters progressively higher temperatures and drier air as it advances and loses moisture.

Vacuum plant can also be used, and this method is in principle the best, but the equipment is more expensive and requires more expert attention. Its installation is not recommended unless work is to be carried out on a fairly large scale and a future regular outlet for the product is reasonably certain.

Suitable equipment is made by various British firms manufacturing drying plant, the names of which can be obtained on application to the Imperial Institute.

Colour and Appearance.—The colour of the finished product is greatly improved if the bananas, after peeling and before drying, are treated with sulphur dioxide. This is done by exposing them to the fumes of burning sulphur. The length of exposure required is generally from about 15 to 30 minutes in the case of fruit split longitudinally into two pieces. It is important to note that the finished product should not contain sulphur dioxide in excess of the quantities permitted by the food laws in the country in which it is to be sold.

The chief problem in the manufacture of banana figs is to obtain a product of pleasing appearance. It should be of a pale yellow or golden colour, having an aroma suggesting that of the fruit, not of a confectionery preparation. It should be of uniform consistency, free from crust and not sticky on the surface.

The attainment of these qualities involves care in carrying out the drying. Too high a temperature will result in the formation of a brownish crust which not only hinders the evaporation of the

moisture in the interior but detracts from the appearance of the product and may impart a " burnt " taste to it. Whatever method of drying be adopted the temperature should not at any time exceed 140° F. Considerably lower temperatures are employed in the case of vacuum drying.

As already indicated an important desideratum is the avoidance of stickiness and dark colour in the finished product. The preliminary sulphuring, as recommended above, probably does much to avoid both these conditions. According to Kervégant (*Le Bananier et son Exploitation*, 1935), it renders inactive the oxidases that cause darkening of the fruit, and at the same time it facilitates drying by making the material less hygroscopic. Furthermore it is claimed that there is less destruction of vitamins in the case of fruit that has been sulphured before drying.

As a further precaution against stickiness it has been suggested that the figs should be lightly dusted with banana flour.

The finished product should contain not more than 20 per cent. of moisture, 15 per cent. being a preferable figure. The yield of figs may be taken at 10 to 14 per cent. of the weight of the bunches of fresh fruit (including stems).

Packing.—The method of packing is a matter of importance. Banana figs are commonly packed under light pressure in wooden boxes containing 28 lb., 56 lb., and sometimes 100 lb. When packed in this way their separation into small quantities for retail purposes is not an easy matter, and for retail sale it is recommended that they should be packed in small cartons with attractive coloured labels at the point of production. Ordinary paper cannot be employed owing to the sticky nature of even the best prepared figs, but " butter " paper or " Cellophane " can be used.

The figs should be of uniform size in any one package, and with this object they should be separated according to sizes before drying.

II. Banana Chips and Flour

Banana flour is obtained by drying bananas at a stage short of full ripeness, before the starch has become converted into sugar. Some varieties of banana are more suitable than others ; the best is stated to be the plantain, *Musa paradisiaca*, in which only a small proportion of the starch becomes converted into sugar even when the fruit is quite ripe. In practice, however, as in the case of banana figs, the varieties employed are mainly Gros Michel and Cavendish, and it is essential that they should be taken at the right stage, which is generally described as fully grown, unripe or three-quarter ripe.

Banana Chips.—The usual practice is to begin by preparing banana " chips." The fruit is first peeled. This is more difficult with green bananas than with fully ripe ones, but it can be facilitated by first plunging the fruit into very hot (not boiling) water, say

at about 170° F. for 4 or 5 minutes. Knives made of bamboo, wood or stainless steel can be used, but ordinary steel must be avoided. The peeled fruit can be dried whole, or cut into longitudinal sections, but it is more usually cut transversely into slices about $\frac{1}{8}$ to $\frac{1}{4}$ in. thick. These slices are then dried by one or other of the means described in the case of banana figs. Sun-drying can be used, and this is perhaps less objectionable than in the case of figs, but artificial means are to be recommended as more reliable.

The dried " chips " should contain not more than about 10 per cent. of moisture, in order to ensure good keeping qualities. The yield is about 10 to 12 per cent. on the fresh bunches, including stalks.

Banana Flour.—The conversion of the chips into flour is simply a matter of milling to obtain a fine powder.

There are also methods of preparing flour from the peeled bananas without first making chips. According to one process the peeled bananas are crushed to a paste, which is then dried by passing it on to hot rotating cylinders. By this means it is dried in a few seconds and obtained in the form of flakes, which are then easily reduced to flour.

Proposals have recently been made in Ecuador to prepare dried *ripe* bananas in flake form for use in conjunction with breakfast foods, etc. The same suggestion has been made with reference to the utilisation of bananas in Fiji. So far, however, the process does not appear to have progressed much beyond the experimental stage.

Another method that can be employed for the production of banana flour is by the use of a spraying process, the pulped fruit being atomised in a warm chamber and by this means converted into a dried powder almost instantaneously. This spraying process has been successfully applied to *ripe* bananas. The product so obtained contains sugars, as well as vitamins, and is claimed to be more suited for the preparation of children's and invalid foods than flour made from green bananas,

A method has also been used in Jamaica whereby the peeled bananas are dried in a vacuum apparatus containing an arrangement of rotating paddles and fixed knives. The disintegrated material so obtained is passed through fine sieves, the coarse fractions being further milled till the whole is reduced to the desired degree of fineness.

In the manufacture of banana chips and flour higher temperatures are permissible than in the case of the figs, but there is danger of darkening if the temperature is allowed to exceed 200° F.

It should be emphasised that there is practically no demand in consuming countries for imported banana flour, the demand being for the product in the form of chips, which are subsequently converted into flour. This is because the material preserves its qualities better in the form of chips; the chips are more conveniently shipped; manufacturers in the consuming countries prefer

their own milling methods, and the possibility of adulteration is avoided.

Banana chips are commonly shipped in jute bags lined with impermeable paper.

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Values of Various Protein Feeds for Growing Chicks. By R. M. Sherwood and J. R. Couch. *Bull. No.* 588, *Texas Agric. Exp. Sta.* Pp. 20, 9 × 6. (Brazos County: Texas Agricultural Experiment Station, 1940.)

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Chemical Constants of Lac. Some Notes on the Acid Saponification and Hydroxyl Values of Lac. By B. S. Gidvani and J. M. Dobbie. *Bull. No.* 4 *Lond. Shellac Res. Bur.* Pp. 15, 8½ × 5½. (London: Shellac Research Bureau, 1940.)

Lac-Cellulose Lacquers. By B. S. Gidvani and R. Bhattacharya. *Tech. Pap. No.* 19, *Lond. Shellac Res. Bur.* Pp. 23, 8½ × 5½. (London: Shellac Research Bureau, 1940.)

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Het kunstmatig drogen van Java wattle-bast (*Acacia decurrens* Willd.). By D. A. Fernandes. *Tectona*, 1940, **33**, 465-481. The artificial drying of Java wattle bark.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 13

(October-December 1940)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Some Fish-poison Plants and their Insecticidal Properties. By F. Tattersfield, J. T. Martin and F. N. Howes. *Kew Bull.*, 1940, No. 5, 169-180. The most interesting of those described are *Derris trifoliata* Lour., *Dolichos pseudopachyrhizus* Harms., *Millettia pachycarpa* Benth., *Tephrosia macrocarpa* (E. Meyer) Harv. and *T. vogelii* Hook. f., though none proved to be of the same order of effectiveness as *Derris elliptica*. Other plants mentioned include *Barringtonia racemosa* Roxb., *B. asiatica* Kurz., *Barringtonia* sp., *Careya australis* F. Muell., *Dioscorea* sp. (" Tuba sakut "), *Ipomoea* sp., *Jacquinia* sp., *Ostryoderris gabonica* Dunn and *Tephrosia* sp.

Ministerio das Relacoes Exteriores, Rio de Janeiro, Brasil. " Brasil—1939-40." pp. 283-286. Review of production of timbo, derris and pyrethrum in Brazil.

Invloed van derris, flit en andere insecticiden op menschen en dieren. (Effect of derris, " flit " and other insecticides on man and animals.) *Bergcultures*, 1940, **14**, No. 25, 808, 810. Discusses cases of dermatitis, etc., caused by derris and pyrethrum.

Concentrated Spray Mixtures and their Application (to Forest and Shade Trees) by Ground and Aerial Equipment as compared with Standard Spraying and Dusting Methods. By S. F. Potts. *U.S. Dep. Agric. Bur. Entomol. Plant Quarantine*, E.508, 1940. (*Amer. Chem. Abstr.*, 1940, **34**, 6755.) Concentrated derris and nicotine sprays coated to reduce deterioration caused by light, air and moisture.

Sheep Blow-Fly Investigations. VIII. Observations on Larvicides and Repellents for Protecting Sheep from Attack. By R. P. Hobson. *Ann. Appl. Biol.*, 1940, **27**, No. 4, 527-532. In tests carried out with larvæ of *Lucilia sericata*, a proprietary derris extract preparation gave fairly satisfactory results as a larvicide, but did not retain any repellent action for long. Oils tested specifically as repellents include olive oil, cotton-seed oil, clove oil, margosa oil, Tagetes oil, rape oil, castor oil, linseed oil and soya-bean oil. Oils of the type of the first two mentioned gave best results, possibly through the formation of oleic acid on going rancid.

What Composition for Roach Powders ? *Soap*, 1940, **16**, No. 10, 92-94, 109. Discusses the merits of pyrethrum, derris and cube used either alone or in conjunction with other insecticides.

Report of the Chief of the Bureau of Entomology and Plant Quarantine 1938-39, U.S. Dep. Agric. (1940). (*R.A.E.*, 1940, **28**, A, Pt. 11, 572-578.) Report includes notes on the effectiveness of oil emulsions with nicotine-bentonite mixture and with cube extract against the pecan nut casebearer and the California red scale ; groundnut oil did not increase the effectiveness of cube dust against the pea Bruchid ; sprays containing derris and groundnut oil were ineffective against gladiolus thrips.

Laboratory Studies of Codling Moth Larval Attractants. By E. H. Siegler. *J. Econ. Ent.*, 1940, **33**, No. 2, 342-345. Addition of brown sugar to nicotine-bentonite, phenothiazine and certain arsenates increased toxicity

under laboratory conditions, but with pyrethrum and derris the added sugar had no value as an attractant.

Tests of Rotenone, Anabasine, Nicotine and other Insecticides against the Woolly Apple Aphid and the Apple Aphid. By M. A. Yothers and S. W. Griffin. *J. Econ. Ent.*, 1940, **33**, No. 5, 800-807.

Effect of Pyrethrum and Derris on the Black Blister Beetle. By F. F. Smith and W. N. Sullivan. *J. Econ. Ent.*, 1940, **33**, No. 5, 807-810.

Boll Weevil and Miscellaneous Cotton Insect Investigations. By F. F. Bondy and C. F. Rainwater. *Rep. S. Carolina Exp. Sta.*, 1937-38, **51** (1938), 114-125, and 1938-39, **52** (1939), 124-134. (*R.A.E.*, 1940, **28**, A, Pt. 12, 647 and 649-650.) Derris and cube dust mixtures proved more satisfactory than nicotine sulphate dusts for keeping down *Aphis gossypii*.

Whitewash to control Potato Leafhopper on Citrus. By R. S. Woglum and H. C. Lewis. *J. Econ. Ent.*, 1940, **33**, No. 1, 83-85. (*R.A.E.*, 1940, **28**, A, Pt. 12, 616.) Pyrethrum and rotenone dusts and sprays did not prove satisfactory; nicotine dust gave partial control but was uneconomical.

Investigations in Control of Hemipterous Cotton Insects in Arizona by the Use of Insecticides. By T. P. Cassidy and T. C. Barber. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine*, E.506, 1940. (*Amer. Chem. Abstr.*, 1940, **34**, No. 19, 6754.) Pyrethrum, derris and mixtures of these with sulphur proved less effective than certain inorganic insecticides.

Jaarverslag over 1939. Comité ter bestudeering en bestrijding van insectenplagen in bosschen. (Annual Report for 1939 of the Committee for the Study and Control of Forest Pests.) *Tijdschr. Heidemaatsch.*, reprint (Arnhem, 1940). (*R.A.E.*, 1940, **28**, A, Pt. 10, 499.) Reference to satisfactory use of dusts combining pyrethrum and derris powders in low strength against *Diprion pini* on pines; also effective control of sawfly larvæ on larch and spruce by means of pyrethrum with derris or calcium cyanamide.

Comment se défendre contre *Laphygma exigua* Hbn. By R. Bouhélier. *Rev. Zool. Agric.*, 1939, **38**, No. 2, 17-26. (*R.A.E.*, 1940, **28**, A, Pt. 10, 502.) Sprays containing nicotine, nicotine sulphate or derris extract found unsatisfactory.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Exports of Nicotine Sulphate from the United States, 1935-1939, and six months of 1940. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 35, 569.

Nornicotine as the Predominating Alkaloid in Certain Tobaccos. By L. N. Markwood. *Science*, 1940, **92**, 204-205. (*Amer. Chem. Abstr.*, 1940, **34**, No. 20, 7059.) Possible insecticidal value of nornicotine which has been isolated in 95 per cent. yield from a low-nicotine strain of tobacco.

Toxicities of optically active Nicotines and Nornicotines to *Aphis rumicis*. By R. Hansberry and L. B. Norton. *J. Econ. Ent.*, 1940, **33**, No. 5 734-738.

Penetration of Nicotine into the Goldfish from Solutions of various Hydrogen-ion Concentrations. By L. O. Ellisor and C. H. Richardson. *J. Cellular and Comparative Physiology*, 1938 **11**, No. 3.

Effect of *p*H on the Toxicity of Nicotine injected into the Cockroach *Periplaneta americana* L. By C. H. Richardson and L. O. Ellisor. *Iowa State Coll. J. Sci.* 1940 **14**, No. 3, 305-316.

Determination of Nicotine in the Presence of Anabasine. By A. A. Shmuk and A. Borozdina. *J. Appl. Chem., U.S.S.R.*, 1939, **12**, 1582-1585. (*Amer. Chem. Abstr.*, 1940, **34**, No. 20, 7063.)

Acute Nicotine Poisoning in Man and Animals. By Pieritz. *Z. Veterinark*, 1938, **50**, 405-413. (Abstract in *Vet. Bull., Weybridge*, 1940, **10**, No. 11, 879.) Cases of poisoning arising from the application to the skin of a solution used to destroy lice.

Persistence of Nicotine on Rose Bushes sprayed with Nicotine Sulfate Combinations. By L. H. Dawsey and L. N. Markwood. *J. Econ. Ent.*, 1940, **33**, No. 5, 722-723.

Avoiding Obvious Residue from Nicotine-Bentonite Sprays. By C. G. Vinson and S. A. McCrory. *Science*, 1940, **92**, 79. (*Amer. Chem. Abstr.*, 1940, **34**, No. 19, 6755.) Describes method of preparing a stable suspension.

Supplementary Spray Materials for Use with Nicotine Peat. By L. H. Dawsey and L. N. Markwood. *J. Econ. Ent.*, 1940, **33**, No. 5, 717-722.

Dep. Agric. Punjab. Summary of more important results arrived at by the Agricultural Stations and Research Officers during 1935-36 to 1937-38 (1940), p. 145. Satisfactory results against *Pyrilla* on sugar cane obtained with nicotine sulphate dust mixtures.

Annual Administration Report of the Department of Agriculture, United Provinces, for the year ending June 30, 1939 (1940), p. 32. Combined soft soap-nicotine spray which gave 100 per cent. mortality under laboratory conditions did not prove so effective in the field.

Utilisation of Tobacco Infusion in Mosquito Control. (In Russian.) By K. G. Dzhangirov. *Med. Parasitol.*, 1939, **8**, No. 5, 93-94. (*R.A.E.*, 1940, **28**, B, Pt. 10, 186.) A spray containing 0·1 per cent. nicotine and made by steeping tobacco dust in cold water proved effective against adult mosquitos, but did not keep in good condition for more than a short time.

Some Common Insect Pests of Fruit Trees and Vines in South Australia. Pt. II. Sucking Insects. *J. Dep. Agric. S. Australia*, 1940, **43**, No. 9, 633-646. Nicotine sulphate sprays recommended for control of various aphids and plant bugs.

Insect Pests of Fruit Trees in Kumaun and their Control. By H. N. Sharma and B. N. Singh. *Bull. No.* 21, *Dep. Agric. United Provinces* (1940). Gives composition of a nicotine sulphate-soft soap spray which is recommended for use against woolly aphis (*Eriosoma lanigerum*) on apple trees and against the leaf curling peach aphis (*Anuraphis helichrysi*).

Additional Records on the Effectiveness of several Insecticides against three Cotton Insects. By G. L. Smith, A. L. Scales and R. C. Gaines. *J. Econ. Ent.*, 1939, **32**, No. 6, 798-802. (*R.A.E.*, 1940, **28**, A, Pt. 9, 475.) Nicotine-bentonite alone or with nicotine tannate proved less satisfactory than the arsenates and sulphur dusts tested for control of *Anthonomus grandis*.

The Value of Nicotine in Codling Moth Control. By W. S. Hough. *Trans. Peninsula Hort. Soc.*, 1939 (1940), 72-76. (*R.A.E.*, 1940, **28**, A, Pt. 10, 519.)

Studies in the Biology and Ecology of *Retithrips syriacus* Mayet, with special Attention to its Occurrence in Palestine. By E. Rivnay. *Bull. Soc. Fouad. 1er Ent.*, 1939, **23**, 150-182. (*R.A.E.*, 1940, **28**, A, Pt. 11, 551.) Satisfactory control from nicotine sulphate spray.

The Black Bug of Sugarcane (*Macropes excavatus*). By K. A. Rahman and R. Nath. *Indian J. Ent.*, 1939, **1**, Pt. 3, 25-34. (*R.A.E.*, 1940, **28**, A, Pt. 11, 558-559.) Nicotine sulphate fish-oil soap spray effective against young nymphs.

La chenille velue de la lavande (*Diacrisia purpurata* L.). By R. Pussard. *Rev. Zool. Agric.*, 1940, **38**, No. 1, 1-11. (*R.A.E.*, 1940, **28**, A, Pt. 10, 501.) Complete control of mature larvæ obtained with nicotine sulphate spray.

Other Alkaloid-containing Materials

Microchemical Detection of Anabasine in Legal Chemical Investigations. By M. D. Shvaikova. *Farmatsiya i Farmakol.*, 1938, No. 3, 10-17. (*Amer. Chem. Abstr.*, 1940, **34**, No. 18, 6411.)

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Annual Report for 1939, East African Agricultural Research Station, Amani (1940), pp. 14-15. Brief progress report by biochemist on investigational work into the occurrence of rotenoids in certain Papilionaceæ.

Detection and Estimation of Hydrorotenone in the Hydrogenation Products of Rotenone. By L. D. Goodhue and H. L. Haller. *Ind. Engng. Chem., Anal. Ed.*, 1940, **12**, No. 11, 652-653.

Action physiologique sur les larves de moustiques de *Derris elliptica* Benth. By E. Roman and G. Netein. *Bull. Men. Société Linnéenne de Lyon*, 1939, No. 3, 74.

The Effect of Alkaline Dust Diluents on Toxicity of Rotenone-bearing Roots as determined by Tests with Houseflies. By T. C. Allen and J. W. Brooks. *J. Agric. Res.*, 1940, **60**, No. 12, 839-845. Rotenone dusts made up with highly alkaline diluents showed loss of toxicity when stored under damp conditions where acid dusts retained their toxicity. Addition of sulphur prevented this deterioration of alkaline dust mixtures.

Influence de la température sur le pouvoir insecticide des poudres roténonées. By J. Feytaud and P. de Lapparent. *C.R. Acad. Agric. France*, 1940, **26**, No. 11, 408-412. (*R.A.E.*, 1940, **28**, A, Pt. 12, 595.) High temperatures were found to accelerate the lethal action of rotenone although the mortality was eventually the same at low temperatures.

Sur le choix du véhicule et sur la conservation du pouvoir insecticide des poudres roténonées. By J. Feytaud and P. de Lapparent. *Rev. Zool. Agric.*, 1940, **38**, Nos. 11-12, 97-112, 118-122. (*R.A.E.*, 1940, **28**, A, Pt. 12, 653. Title only.) Effect of different carriers on toxicity and lasting qualities of a cube dust.

Abstracts of Recent Foreign and Domestic Patents relating to Derris, Lonchocarpus, Tephrosia and Rotenone. By R. C. Roark. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine*, E.514, 1940. (First Supplement to E.446.)

Rotenone Useful on Garden Pests. *The Waho News Letter*, 1940, **23**, No. 6.

Rotenone as Cure for Scabies. *Mfg. Chem.*, 1940, **11**, No. 10, 270. Brief note.

Études sur l'éradication des puces. By E. Roubaud. *Bull. Soc. Path. Exot.*, 1940, **33**, No. 3, 153-156. (*R.A.E.*, 1940, **28**, B, Pt. 10, 190.) Rotenone dust mixtures gave effective control of adult fleas on animals. Such mixtures too expensive for general use against the larvæ and crude derris dust not effective.

Carpet Beetle Control. *Soap*, 1940, **16**, No. 10, 111 (from *Pests*, 1940, **8**, No. 5, 10-12). Note that high concentrations of rotenone have proved effective.

Pea Aphid Investigation in Maryland. By C. Graham. *Trans. Peninsula Hort. Soc.*, 1939 (1940), 29-34. (*R.A.E.*, 1940, **28**, A, Pt. 10, 517.) Results of experiments with various rotenone sprays and dusts.

Control of *Aphthona euphorbiæ* on Flax with Rotenone Powders. By J. Martin and J. de la Verrie. *C.R. Acad. Agric. France*, 1939, **25**, 420-424. (*Brit. Chem. Abstr.*, 1940, March, B, p. 235.)

Derris

Annual Reports of the Department of Agriculture, New Guinea, for the year ending June 30, 1939. *New Guinea Agric. Gaz.*, 1940, **6**, No. 2, 8. Brief progress report on cultivation of derris ; little advance has been made.

Annual Report for 1939, East African Agricultural Research Station, Amani (1940), pp. 21, 22, 23. Brief progress report on grafting work with *Derris* species and varieties ; also notes on plantation work with *Derris*.

Cultivation of Derris Root in Tanganyika Territory. *Industr. Engng. Chem., News Ed.*, 1940, **18**, No. 23, 1088. Brief note.

Raiz de derris y otras plantas insecticidas útiles e importantes para su cultive en Guatemala. By Franz Ippisch. *Rev. Agric., Guatemala*, 1940, **17**, 165-172. History of the rise of derris, instructions for its cultivation and preparation.

Commissie van advies inzake de bevordering van de cultuur van handelsgewassen. Akar toebah (*Derris elliptica*). *Bergcultures*, 1940, **14**, No. 45, 1430-1431. The second part of a report by an advisory commission on the promotion of cultivation of economic crops. The section on derris surveys the position generally, with particular reference to production in the Netherlands East Indies and the American market.

Investigation on *Derris* Cultivation from the Chemical Point of View. *Monogr. Gov. Agric. Res. Inst. Taiwan, Nippon* (*Japan*), 1939, No. 73, pp. 40. (*Plant Breed. Abstr.*, 1940, **10**, No. 4, 279.) Discusses improvement of Formosan strains by breeding and selection; possibility of crossing with Malayan strains. Includes figures for total rotenone content of two Formosan strains harvested at different times of year.

The Outlook for Derris. By C. D. V. Georgi. *Malay Agric. J.*, 1940, **28**, No. 8, 358-366. Malayan trade in derris, prices and methods of sampling are discussed, especially in relation to future prospects in the U.S. and competition with cube.

Increased Exports of Derris Root from Philippine Islands in 1939. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 29, 471.

Thirty-fourth Annual Report of the Department of Agriculture, British Columbia, for the year 1939 (1940), p. B.74-B.77. Notes on warble-fly control and treatment of cattle ticks with derris preparations.

Sheep Blow-Fly Investigations. VIII. Observations on Larvicides and Repellents for Protecting Sheep from Attack. By R. P. Hobson. *Ann. Appl. Biol.*, 1940, **27**, No. 4, 527-532. In tests carried out with larvæ of *Lucilia sericata*, a proprietary derris extract preparation gave fairly satisfactory results as a larvicide, but did not retain any repellent action for long.

The Control of Sheep Tick. *J. R. Agric. Soc.*, 1940, **100**, Pt. 3, 86-89. Use of dips containing derris and wool grease; also application of derris powder to lambs.

The New Jersey Tick Problem. By T. J. Headlee. *Circ. No.* 395, *N.J. Agric. Exp. Sta.*, 1940. (*R.A.E.*, 1940, **28**, A, Pt. 9, 180.) [Reference to use of derris-talc mixture for treatment of tick-infested dogs.

Vergleichende Untersuchungen mit dem Häkchenverfahren und der Derriswaschung zur Dasselbekämpfung bei Niederungsrindern XI. (Control of Ox-warbles in Lowland Cattle by the Hook and Derris-Wash Methods XI.) By J. Helmberg. *Inaug. Diss., Hanover*, 1936, pp. 70. (Abstract in *Vet. Bull., Weybridge*, 1940, **10**, No. 12, 960-1.) Satisfactory results from use of certain derris preparations, especially "Derrislavol" and "Derrophen," and from "a new preparation 'Baravol' made from the root of the South American plant Barbasco or wild cinnamon (*Canella winteriana*)."

Versuche zur Bekämpfung des Dasselbefalls beim Rinde. XII. (*a*) Die Auswirkungen der Entdasselung 1936 auf den Befall 1937. (*b*) Derris-, Barbasco-, Phenolpräparate und mechanische Abdasselung. (Control of Ox-warbles. XII. (*a*) Results of 1936 on incidence in 1937. (*b*) Derris "Barbasco" and Phenol Compounds, and Mechanical Means.) By H. J. Freyer. *Inaug. Diss. Hanover*, 1937, pp. 33. (Abstract in *Vet. Bull., Weybridge*, 1940, **10**, No. 11, 960-961.) Derris washes more effective than "Barbasco." (?—*Canella winteriana*.)

Peanut Oil in Derris Dust Mixtures against the Pea Aphid. By T. E. Bronson and J. R. Dudley, Jun. *J. Econ. Ent.*, 1940, **33**, No. 5, 736-738.

Work in Entomology by the Wisconsin Station. *Sta. Bull.* 449, *Wisconsin Agric. Exp. Sta.*, 1940, pp. 50-67. (*Exp. Sta. Rec.*, 1940, **83**, No. 3, 364.) References to the effectiveness of derris dusts against pea aphids and the resistance of predators of the pea aphid to rotenone.

Toxicants and Solids added to Spray Oil in Control of California Red Scale. By W. Ebbeling. *J. Econ. Ent.*, 1940, **33**, No. 1, 92-102. (*R.A.E.*, 1940, **28**, A, Pt. 12, 617.) Addition of derris resins to oil spray gave considerable increase in effectiveness.

The Bean Pod Borers in Puerto Rico. By L. B. Scott. *J. Agric. Puerto*

Rico, 1940, **24**, No. 2, 35-43. Reference to field experiments using pyrethrum and derris dusts. The former gave moderately effective control but proved too costly, while derris dust was only slightly effective. Derris sprays were moderately effective.

Results of Dusting Experiments for Control of Strawberry Weevil. By J. H. Amos and R. L. Pierpoint. *Trans. Peninsula Hort. Soc.*, 1939 (1940), 150-157. (*R.A.E.*, 1940, **28**, A, Pt. 10, 519.) Derris dusts scarcely economic.

Insects Associated with the Coco-nut Palm. By J. L. Froggatt. *New Guinea Agric. Gaz.*, 1940, **6**, No. 3, 31. Derris dusts used against *Sexava* spp. (Coconut Tree-Hoppers) gave irregular results as against the consistently high mortality obtained with arsenicals.

Lonchocarpus

Algunos datos sobre el barbasco. (Some notes on the Barbasco.) By L. Williams. *Bol. Soc. Venezolana de Ciencias Naturales*, No. 41, 1939. (*For. Abstr.*, 1940, **2**, No. 2, 155.) Investigation of "Barbasco Blanco" (*Lonchocarpus* sp.) showed rotenone contents in the root and shoot of between 0·37 and 1·77 per cent. by dry weight.

Experiments with Insecticides as a Control for the Tomato Worm and Flea Beetle on Tobacco. By N. Allen, J. W. Humphreys and D. B. Lieux. *Rep. S. Carolina Sta.*, 1937-38, **51** (1938), 136-144. (*R.A.E.*, 1940, **28**, A, Pt. 12, 648.) Effective control of flea beetle given by cube dust containing 1 per cent. rotenone.

Others

Annual Report for 1939, East African Agricultural Research Station, Amani (1940), pp. 22, 23. Brief note on plantation work with *Tephrosia*.

The Non-crystalline Constitutents of *Tephrosia virginiana* Roots. By L. D. Goodhue and H. L. Haller. *J. Amer. Chem. Soc.*, 1940, **62**, No. 9, 2520-2522.

PYRETHRIN-CONTAINING MATERIALS

Report of Forest Administration in the Mysore State for year ending June 30, 1939 (1940), pp. 26 and 31. Reference to progress of experimental cultivation of pyrethrum at Kemmangundi.

Annual Administration Report of the Department of Agriculture, United Provinces, for the year ending June 30, 1939 (1940), p. 58. Brief reference to cultivation trials with pyrethrum.

Cultivation of pyrethrum. By R. A. Dyer. *The Farmer* (*Natal*), 1940, July 26, 35.

Large Profits from Pyrethrum Growing in Kenya. *The Farmer* (*Natal*), 1940, October 11, 19. Pyrethrum growing in Kenya and possibilities of the crop in South Africa.

The Advantages and Uses of Pyrethrum as an Insecticide. By B. Smit. *Fmg. S. Afr.*, 1940, **15**, No. 176, 408.

Domestic Pyrethrum Costs. *Soap*, 1940, **16**, No. 10, 119. Note of costs of a test pyrethrum planting in California with a view to cultivation on a larger scale.

Report of work with Economic Insects in Western Washington. *Western Washington Sta. Rept.*, 1939, pp. 19-25. (*Exp. Sta. Rec.*, 1940, **83**, No. 2, 217.) Reference to pyrethrum as a crop for Western Washington.

Commissie van advies inzake de bevordering van de cultuur van handelsgewassen. Pyrethrum (*Chrysanthemum cinerariæfolium*). *Bergcultures*, 1940, **14**, No. 45, 1431-1432. The second part of a report by an advisory commission on the promotion of cultivation of economic crops. A general survey of world production of pyrethrum and Netherlands East Indies trials makes up the section on pyrethrum.

Japanese Pyrethrum Exports. *Soap*, 1940, **16**, No. 10, 14. Note on 1939 and 1940 exports.

Comparative Estimation of the Pyrethrin Content of Various Species of Dalmatian Camomile. By D. I. Nosov. *Farmatsiya i Farmakol*, 1938, No. 6, 27-32. (Abstract in *Chem. Zentbl.*, 1939, I, 1201.)

Pyrethrum Labelling. *Soap*, 1940, **16**, No. 10, 113. Note that milled pyrethrum is being sold in barrels labelled on a basis of 0·5 per cent. active, irrespective of the fact that the pyrethrum may run 0·9 per cent. or higher, and may be made from Japanese, Kenya or Dalmatian flowers.

Pyrethrum and White Oil. *Rhod. Agric. J.*, 1940, **37**, No. 9, 528. Note regarding the use of a strong mixture of pyrethrum and white oil as high pressure atomised spray against insects attacking bagged grain in store rooms.

Household Spray Insecticides, Brazil. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 39, 633. Local demand practically met by domestic manufacture, including pyrethrum grown locally.

A Comparative Evaluation of Paris Green and Pyrethrum Emulsion as Anopheline Larvicides in Georgia; A Progress Report. By J. M. Henderson and R. S. Howard, Jun. *Amer. J. Trop. Med.*, 1940, **20**, No. 4, 585-592. (*R.A.E.*, 1940, **28**, B, Pt. 11, 232.) Mentions disadvantages of pyrethrum in that it kills certain mosquito predators which Paris green does not.

Cattle Fly Sprays. *Indian Fmg.*, 1940, **1**, No. 9, 441-442. Note on increased milk yield resulting from the use of a repellent spray containing pine oil and a proprietary preparation of pyrethrum.

Dusting for Froghopper in Wattles. By L. B. Ripley and B. K. Petty. *Fmg. S. Afr.*, 1940, **15**, No. 171, 218, 222. Pyrethrum diluted with talc proved most efficacious. Rate of application and costs discussed.

Control of Blackflies (Simuliidæ). By R. D. Glasgow. *J. Econ. Ent.*, 1939, **32**, No. 6, 882-883. (*R.A.E.*, 1940, **28**, B, Pt. 10, 176.) Use of pyrethrum extract.

Preliminary Report of Lubberly Locust control. By J. R. Watson and H. E. Bratley. *Florida Ent.*, 1940, **23**, No. 1, 7-10. (*R.A.E.*, 1940, **28**, A, Pt. 11, 542.) Pyrethrum sprays found effective against the hoppers.

The Bean Pod Borers in Puerto Rico. By L. B. Scott. *J. Agric. Puerto Rico*, 1940, **24**, No. 2, 35-43. Reference to field experiments using pyrethrum and derris dusts. Pyrethrum gave moderately effective control but proved too expensive.

Biologie und Bekämpfung des Apfelblütenstechers (*Anthonomus pomorum* L.). By W. Speyer. *Arb. Physiol. Angew. Entomol. Berlin-Dahlem*, 1939, **6**, 286-308. (Abstract in *Chem. Zentbl.*, 1939, II, No. 25, 4318.) Tests were made with pyrethrum and quassia preparations.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Cashew Nut-Shell Oil. By M. T. Harvey and S. Caplan. *Ind. Engng. Chem., Industr. Ed.*, 1940, **32**, No. 10, 1306. Newer methods of treatment mentioned. Potential supply large.

Nouvelles formules de traitement d'hiver des arbres fruitiers contre les cochenilles et les oeufs de pucerons. By A. Paillot. *C.R. Acad. Agric., France*, 1940, **26**, No. 7, 221-224. (*R.A.E.*, 1940, **28**, A, Pt. 10, 504.) Different concentrations of groundnut oil emulsions tested.

Peanut Oil in Derris Dust Mixtures against the Pea Aphid. By T. E. Bronson and J. R. Dudley, Jun. *J. Econ. Ent.*, 1940, **33**, No. 5, 736-738.

Report of the Chief of the Bureau of Entomology and Plant Quarantine 1938-39, U.S. Dep. Agric. (1940). (*R.A.E.*, 1940, **28**, A, Pt. 11, 572-578.) Groundnut oil did not increase the effectiveness of cube dust against the pea Bruchid; sprays containing derris and groundnut oil ineffective against gladiolus thrips.

The Use of Oil of Citronella for the Protection of Lambs against Blowfly

Strike. By F. G. Lennox. *J. Coun. Aci. Industr. Res., Aust.*, 1940, **13**, No. 2, 65-73.

Biologie und Bekämpfung des Apfelblütenstechers (*Anthonomus pomorum* L.). By W. Speyer. *Arb. Physiol. Angew. Entomol. Berlin-Dahlem*, 1939, **6**, 286-308. (Abstract in *Chem. Zentbl.*, 1939, II, No. 25, 4318.) Quassia preparations tested.

Beitrag zur Biologie und Bekämpfung der Apfel- und Birnen- Sägewespe. By Helmut Velbinger. *Gartenbauwiss, Berlin*, 1939, 13, 492-566. (Abstract in *Chem. Zentbl.*, 1939, II, No. 25, 4318.) Satisfactory results with quassia sprays; nicotine ineffective.

The Tropical Grass *Melinis minutiflora* as a Preventive against Malaria and other Tropical Diseases. By E. Morgan. *J. Trop. Med. Hyg.*, 1940, **43**, No. 13, 179. (*R.A.E.*, 1940, **28**, B, Pt. 12, 248.) The grass, which has a peculiar penetrating odour, acts as a repellant as mosquitoes are absent from pastures planted with it, and tick-infested cattle become free from the pests on such pastures. These properties are probably due to an oil present in the grass when in the green stage.

Vergleichende Untersuchungen mit dem Häkchenverfahren und der Derriswaschung zur Dasselbekämpfung bei Niederungsrindern XI. (Control of Ox-warbles in Lowland Cattle by the Hook and Derris-Wash Methods XI.) By J. Helmberg. *Inaug. Diss., Hanover*, 1936, pp. 70. (Abstract in *Vet. Bull., Weybridge*, 1940, **10**, No. 12, 960-1.) Contains reference to a preparation " Baravol " said to be made from the root of the South American plant barbasco or wild cinnamon (*Canella winteriana*).

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

AGRICULTURE IN UGANDA. By the Staff of the Department of Agriculture, Uganda. Edited by J. D. Tothill, C.M.G., D.Sc. Pp. xvi + 551, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Humphrey Milford, Oxford University Press, 1940.) Price 20s.

This volume, published by authority of the Government of the Uganda Protectorate, is intended as a companion volume to *Uganda*, by T. and R. Scott, published in 1935. It deals with every aspect of agriculture in the Protectorate, from a consideration of the soil and climatic conditions to the final marketing of the crops. Each section has been compiled by the appropriate expert officer of the Department of Agriculture, whilst the assistance of officers of the Meteorological Service, the Geological Survey and the Administration, as well as of planters, has also been called in where necessary. The book, therefore, is in every sense of the word authoritative. It not only gives practical advice on the cultivation and preparation of the various crops, but records in a convenient form the results of the vast amount of scientific investigation conducted by the Department over a long period of years and which has hitherto been available only in scattered reports, papers and bulletins. There is also a large amount of new material, much of the information on plant pests, for example, being published here for the first time.

The question of the food supply of the native population receives special consideration. The records show how much has been done by the Department in the improvement of supplies of meat and staple foods, such as ground nuts, cassava, sweet potatoes, pigeon pea and bananas, and also in the introduction of others—pulses, vegetables and fruits—in order to add variety to the diet and reduce the frequency and intensity of famine.

After a section on General Agriculture, embracing an account of the topography and vegetation of the country, the climate, land tenure, native crop rotation and methods of cultivation, soils and soil erosion and manures, there is a short description of the various experiment stations and farms run by the Department. Then follow sections dealing with native food crops—bananas, root crops, cereals, ground nuts, pulses and so on. The two most important export crops, cotton and coffee, are dealt with in considerable detail. In this connection a comparative statement of the quantity and value of the various agricultural exports might usefully have been included, if only to emphasise the preponderating importance to the Protectorate of the cotton industry. Sections are also included on sugar, tobacco, plantation crops (cacao, rubber and tea), oil-yielding plants, spices and drugs, fibres, cover crops and shade trees, fruits and vegetables. Livestock, as such, are not considered but there is a short section on grasses and grazing and another on bee-keeping. The methods of marketing of cotton and other native crops are described and the book ends with an account of the Agricultural Education and Extension Work of the Department.

The volume is well illustrated with photographs and there are three maps. In addition to a full general index there are separate indexes to the scientific names of plants (including fungi) and insects.

The Editor and his collaborators are to be congratulated on the production of this excellent work, which should be of very great value to all interested in tropical agriculture.

TEXT-BOOK OF GENERAL HORTICULTURE. By Julian Claude Schilletter and Harry Wyatt Richey. Pp. ix + 367, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 21*s*.

The authors of this textbook are respectively Associate Professor and Professor of Horticulture, Iowa State College, and the work has been prepared for the use of students taking a general introductory course in horticulture at an agricultural college. The aim is to present the fundamentals of the subject rather than details of the culture of individual crops and although the methods of carrying out certain practices are described, emphasis is laid on the why and not on the how. The examples given are naturally taken from American practice, but the underlying principles are the same everywhere and the horticultural student in this country no less than his American cousin will profit by a careful study of the book.

Horticulture is defined as that branch of agriculture which is concerned with the culture of fruits, vegetables and ornamental plants. It is something more than mere gardening, and the first four chapters of the book are designed to show how the subject fits into the field of agriculture and how it enters into the economic, political and social life of the individual. The last of these four chapters on " Horticultural Enterprises of the Home " deals with the layout of the home garden of a farmstead and the flowers, trees, vegetables and fruits that are grown there. The remaining chapters are concerned with the structure and function of horticultural plants, their growth and relation to their environment (temperature, moisture, light and soil), propagation, soil management, training and pruning, pests and their control and the harvesting and storage of the products of horticultural plants.

The Principles and Practice of Feeding Farm Animals. By E. T. Halnan, M.A., and Frank H. Garner, M.A. Pp. x + 359, 8½ × 5½. (London: Longmans, Green & Co., Ltd., 1940.) Price 15s.

The object of this volume is to give livestock students a simple account of the principles of nutrition and their application to the feeding of farm livestock, from the point of view of modern methods of feeding, in which by-products of industry have to a large degree replaced the produce of the farm. The first part of the book, dealing with theoretical considerations, discusses briefly the chemical composition of feeding-stuffs and animals and goes on to consider the digestive processes in the animal, the qualitatives or biological values of feeding-stuffs and finally feeding standards. The second part—" Practical Considerations "—describes the common feeding-stuffs available in normal times in the British Isles, the uses of grassland and its products for livestock, and the preparation of feeding-stuffs, and then deals with general principles underlying the feeding of farm animals. The next seven chapters deal in detail with the feeding of rearing cattle, dairy cows, fattening cattle, sheep, pigs, horses and poultry. Goats are not considered. The last chapter discusses the special problems of feeding livestock in war time, including such matters as increased production of roots, the better utilisation of the remaining grassland, pre-digestion of straw, the special requirements of pigs and poultry, substitute feeding-stuffs, and so on.

Although intended primarily for the student, this volume, in view of its essentially practical character, should be of equal interest and value to the practising farmer.

MINERAL RESOURCES

ARTICLE

GEOLOGY AND MINERAL DEPOSITS OF THE UPPER WAINI RIVER, NORTH-WEST DISTRICT, BRITISH GUIANA*

By D. A. Bryn Davies, Ph.D., B.Sc., A.I.M.M., F.G.S.

INTRODUCTION

Area Surveyed and Methods

The report presents the results of a geological and topographical survey, carried out during the field-season, September-December 1936, over an area of 300 sq. miles in the Upper Waini River country, North-West District, and the headwaters of the Kutuau River, a tributary of the Cuyuni.

The survey was undertaken in order to investigate the mineral deposits of the area, in particular the gold occurrences of the Imotai and of the then recently discovered Arawapai fields, and to explore this hitherto largely unmapped tract of country.

Topographical survey methods consisted of prismatic-compass and cyclometer sound-traverses of trails and cut lines, with compass and time traverses, subsequently adjusted to land lines, along the rivers. Heights were obtained by aneroid barometer, corrected for diurnal variation, and calculated on an assumed elevation of 100 ft. above sea-level at the foot of Maka Falls.

In prospecting for gold and other heavy minerals in the alluvial deposits the usual method of battel-washing was employed. Except in the worked areas, where attention was directed more especially to hill deposits, practically every creek encountered on the traverse was prospected under the writer's direction.

GEOLOGY

The area described is broadly divisible by a north-south median line into an eastern portion consisting of mica-schist and muscovite-granite, intruded by an extensive sill of dolerite, and a western portion comprised of metamorphosed basic rocks and acid to intermediate volcanic rocks intruded by batholiths and stocks of hornblende-granite and diorite. This general picture is modified

* Abridged from a report received from the Under Secretary of State, Colonial Office, January 1941.

by the appearance of granitic stocks east of the main batholith and the extension westwards of dolerite dykes from the main sill.

Excepting the mica-schists and muscovite-granites, the rock types are similar to those already described in the contiguous areas of Aranka and the Lower Barama.

Superficial deposits of sands of the White Sand Series and lateritic ironstone cover large areas as scattered outliers of gently dipping deposits. Terraces of recent alluvial deposits are of local occurrence.

Acid-Intermediate Volcanic Series

Two areas of rocks of this Series occur, one in the south-west in the Kutuau headwaters, and the other in the north-west around Kokerit. In the south-western area the rocks are greenish-grey tuffs and tuffaceous phyllites, often highly sheared and very prone to decomposition. Outcrops are scanty and the mapping is largely dependent on soil character (a fine sandy clay being characteristic), battel concentrates, and observation of the bedrock clays in the gold workings.

Metamorphosed Basic Rocks

Massive and schistose hornblendic rocks, occurring in constant association, outcrop as a wide border along the eastern margin of the Aranka-Kokerit Maenab batholith and project eastwards near the centre of the area. Epidiorites and, occasionally, intercalated quartzitic rocks, occur.

The amphibolites occur mainly in the tongue of basic rocks which projects northwards along the western edge of the Shararin stock. The absence of foliation suggests a later age than the hornblende schists with which they are associated; and it is possible that they represent a basic differentiate of the Shararin diorite.

The lenticular areas of metamorphosed basic rocks shown within the Aranka granite, on the south-western slopes of the Pakira Hills, were mapped on soil character and battel concentrates alone. In the absence of corroborative evidence from outcrops, it is not certain that they are not dolerite dykes.

Red Phyllites

This group, occurring only in the south-eastern corner of the area, is composed of reddish-brown mauve and pale purple micaceous phyllites. They are intermediate in lithology between phyllites and schists, and are characterised by a slaty plane schistosity.

Mica Schists

Quartz-mica-schists and decomposed micaceous gneisses occupy a preponderant portion of the area and extend north, south and east beyond the area mapped. They are characteristically intruded by non-foliated muscovite granites and pegmatites.

Granitic Rocks

Hornblende-granite and Diorite.—The character of the granites of the Aranka-Kokerit Maenab batholith has already been described and the mapping of the area under report has confirmed the supposed eastern limits of the batholith in the Upper Waini. Separate stocks appear eastwards of the main contact in the Minabaru and again over a larger area between and west of Shararin and Haiari Falls. Small lenticular apophyses occur in three localities in the Big Hope area.

Although the granites are typically non-foliated, strong horizontal foliation is developed in the Minabaru stock, and garnetiferous leucocratic varieties occur here.

The main batholith shows no zonal arrangement of type towards its eastern margin, but the Shararin-Haiari stock shows all gradations from a normal hornblende-granite type to diorite. The Minabaru stock, mainly dioritic, is frequently highly contaminated on its western border and basic hybrids are of common occurrence.

In general the granites are of medium grain, with hornblende and biotite as the mafic minerals. Microcline is occasionally a prominent felspar constituent, the plagioclase ranging from oligoclase in the acid types to andesine in the more basic varieties. Interstitial micropegmatite is common in the ground mass.

Mapping of the granite areas is facilitated by the prominence of pink zircon in battel concentrates. In the more basic types, however, black sand is more abundant and the zircon decreases in relative amount. The soils are of the usual medium to coarse sandy clay character.

Muscovite-granite.—Fine-grained muscovite-biotite granites are confined to the mica-schist country in which they are abundantly distributed. Their occurrence amongst the schists is somewhat erratic, and it has not been found practicable to delineate the boundaries of the intrusions. It is possible that they occur as swarms of lenticular stocks and apophyses. Foliation in the muscovite-granites is generally absent, but individual outcrops, such as those at Maka Falls are occasionally strongly foliated and gneissose.

Narrow dykes of muscovite-pegmatite intersect both the muscovite-granites and mica-schists, while in the Shararin and Minabaru stocks, veins of muscovite-pegmatite are intrusive into the hornblende-diorites. They are thus younger than both the muscovite- and hornblende- granites.

Attention was paid to the possibility of mica deposits occurring in the pegmatites, but no crystals exceeding 2 in. in diameter were found. Gold is found associated with the muscovite-granites in only a very few localities and then in restricted amount.

Correlation of the Granites.—The relative age of the muscovite- and hornblende-granites is not clear. They do not occur in close proximity and the former is often mineralised while the latter is

barren. They show a similar degree of localised metamorphism. Their intrusion by dykes of muscovite-pegmatite suggests that the muscovite-granite is at least not older than the hornblende-granite and may be younger.

There would appear to be some significance in the fact that the muscovite-granites are associated only with mica-schists, whereas the hornblende-granites are intrusive mainly into acid to intermediate volcanic and metamorphosed basic rocks. The marked difference in association may indicate that the difference in composition between the two granites is due to assimilation phenomena in one invading magma. The opposition in behaviour of the two granites with regard to gold mineralisation is not, however, clearly explicable on this hypothesis.

Dolerites

The largest of the dolerite intrusions in the area is a sill-like mass which, with a maximum outcrop width of 1½ miles, extends in a northerly direction for a distance of 15 miles from the southern limit of the mapped area to within a short distance of Maka Falls. Its northern termination was not mapped in detail, but is presumably lenticular. To the south the sill continues beyond the area mapped and may possibly connect with the Akaiwong dyke in the Cuyuni River and the Tiboku dolerite range of the Mazaruni.

White Sand Series

The study of the White Sand Series, initiated by S. Bracewell in 1927 and since continued by the officers of the Survey, has indicated its importance as a controlling factor in the distribution of diamonds north of the Kaieteurian escarpment. Further corroborative evidence of this was obtained in the Waini area, the possibility of the occurrence of diamonds here having previously been foreseen as a result of work on the Series in the Aranka district.

The Series in the Waini country consists of white and brown sands (the latter occurring near the base and relatively less important) attaining a maximum thickness of 110 ft. The surface of the deposit is an almost imperceptibly undulating and dipping plateau standing at 600 ft. above sea-level in the south, on the Cuyuni Waini watershed, and losing elevation northwards to 400 ft. above sea-level west of Maka Falls. Although outliers of the sands are now preserved only on the subsidiary watersheds which attain the requisite elevation, the sands must originally have formed a continuous sheet, some 3 miles in width, confined between the hills of the Waini sill on the east and the hornblende-schist ranges of the Imotai headwaters (the Pakira Hills) on the west. Other developments of the Series probably continue on either side of these barriers, but elevations are too low in the area mapped for their preservation.

The direction of dip of the sands is north-north-east; in view

of the general easterly dip which is prevalent in other parts of the colony, this may be an apparent rather than a true dip.

At the base of the Series occasionally thick deposits of worn quartz gravels occur, and are best developed in the Waini and Kutuau headwaters. Elsewhere they are not prominent in outcrop but worn gravels derived from them are usually seen in the creeks draining from the white sands. In the Upper Kutuau, cream-coloured loosely-cemented and false-bedded sandstones, about 30 ft. thick, are exposed at the base of the Series in a creek head 1½ miles west of La Rose's camp. The sandstones include occasional scattered pebbles of worn quartz and white clay. The clay pebbles are the only evidence in the area of the white clays which form a constant feature at the base of the Series elsewhere in the Colony.

The worn gravels show a pronounced diminution in quantity and pebble-size from south to north. West of Maka Falls rounded pebbles are found with difficulty in the sands. Their distribution suggests a southerly source for the gravels.

Diamonds are associated with the worn gravels in the sand areas of the Upper Kutuau and of the country west of Haiari Falls ; they occur in the alluvial deposits of recent origin derived, in part, from the Series.

In view of the widespread occurrence of the white sand, although extensively eroded, there can have been little erosion of the escarpment since the deposition of the sands. The sands and worn gravel of the Waini may thus, in part, have been transported a distance of some 80 miles.

The problem of the distribution of diamonds resolves into that of the old drainages north-eastwards from the Kaieteurian escarpment. Diamonds may be expected to occur wherever worn gravels of the Series are being or have recently been eroded and will decrease in quantity and size north-eastwards from the escarpment. Given detailed topographical and geological maps, the course of the old diamond-bearing channels should be capable of definition.

The sands are confined, except for a small area at the head of the Arangoy, to the areas of mica-schist, granite, and acid volcanic rocks. The basic rocks which, as they still do, stood out in ridges above the general level, accumulated during the period of sand deposition a thin superficial deposit of lateritic ironstone.

Lateritic Ironstone

Horizontal and gently dipping deposits of lateritic ironstone cover large areas on the basic rocks. Both cellular laterite and the laterite-cemented laterite-gravel type are represented. The majority of the outliers have an elevation of from 700 to 500 ft. above sea-level with a tendency for a northerly dip in conformity with that of the White Sand Series. Pronounced plateaux occur at higher elevations in the Pakira hills and at the head of the Minabaru, one at 900 ft. and another forming the summit of the Pakira range at

1,300 ft. In the latter the ironstones attain a thickness of 15 ft. and have a north-easterly dip. Thin bands of laterite-gravel are intercalated in the cellular laterite, denoting some amount of alluvial deposition during the formation of the deposit. Low-level laterites, at between 400 and 500 ft. elevation occur at the base of the Pakira Hills in the Imotai headwaters, and in the Waini valley on the north-west line from 7½ miles, Arawapai Trail, and near Arawapai Landing. In view of the possibility that the ironstones developed on a gently undulating surface, perhaps occasionally with a strong relief, it would be difficult to postulate, without more detailed mapping, a series of base-levels of erosion to which the plateau ironstones correspond. A correlation may be made, however, between the 700 to 500 ft. ironstone plateaux and those of the White Sand Series. Those at the 900 and 1,300 ft. elevations may be contemporaneous or of an earlier formation. The low-level laterites, occurring slightly below the base of the White Sand Series are probably younger than the Series, and to be related to more recent local base-levels.

ECONOMIC MINERALS

Gold

In the absence of gold deposits in bedrock within the area, the data on which a discussion of the gold mineralisation rests are necessarily derived from a study of the alluvial deposits. It is known, from work in this and other areas of the northern portion of the Colony that the migration of gold from its source, in the normal course of erosion, is inconsiderable. This is due mainly to the generally decomposed, clayey character of the bedrock, which precludes extensive water-borne travel of heavy minerals, and also to the low stream-gradients. The geological environment of the alluvial gold deposits may thus be accepted as substantially that of the mineralised bedrock from which the alluvial gold is derived.

The argument does not hold in the case of the older alluvial deposits of the White Sand Series since these frequently carry diamonds which must have been transported for considerable distances from their source. There is no reason to believe, however, that any of the workable gold concentrations of the area bear any relation to the distribution of the White Sand Series.

Excepting the dolerites, gold occurs within every formation in the area, as follows:

(1) Imotai field; in metamorphosed basic rocks intruded by apophyses of hornblende-granite.
(2) Minabaru field; in both metamorphosed basic rocks and hornblende-granite, mainly along the contact.
(3) Arawapai field; in acid to intermediate volcanic rocks.
(4) Minor occurrences; in scattered localities in the mica-schists intruded by muscovite-granite.

In the Aranka goldfield and the Ianna, Pipiani and Yakishuru

fields of the lower Barama, auriferous hornblende-granites are constantly associated with the gold deposits.

A persistent geological factor in the gold mineralisation of an area covering some 700 sq. miles is thus the intrusion of hornblendic granitic rocks.

A symmetrical disposition of the gold-bearing areas to the margins of the main granite batholith is evident. The Tinambo and Arawapai fields lie at a distance of 5 miles from the north-easterly and south-westerly projections respectively of the batholith, while the Imotai and Minabaru fields, associated with stocks and apophyses of granitic rocks, occupy a median position opposite the deep indentation of the main batholith in the upper Imotai.

The batholith, along its eastern margins is comparatively barren of gold, while the small stocks are well mineralised.

The well-known association of gold with granitic contacts, and its relative scarcity within the main body of large batholiths suggests its general restriction to the margins and overlying country rocks of the intrusions. In the Waini area, however, the margin of the batholith is practically barren, and it is reported that a similar absence of workable gold deposits occurs along the northern margin of the batholith, parallel and south of the Barama River. It is to be noted, however, that the contact and near-contact deposits which form an important proportion of the gold fields of the Colony occur mainly along the southern margins of batholiths, e.g. Aranka, Aremu, Pipiani, Tamakay and Issineru. There would thus appear to be some additional structural control which determines the provenance of this type of mineralisation.

It is concluded that the gold mineralisation of the area under discussion is intimately related to the intrusion of hornblendic granitic rocks and that, in the fields where these rocks are not exposed, they lie, probably as stocks, at shallow depths. The muscovite-granites, and the mica-schists into which they are intruded are, for practical purposes, barren.

General Distribution

In the area with which the report is concerned there are three main gold-bearing areas, viz., the Big Hope Creek area, generally known as the Imotai field, covering an area of some 3 sq. miles, the Minabaru area, also on tributaries of the Imotai, with an area of 2 sq. miles, and the Upper Kutuau area, known as the Arawapai field, in which the workings and indicated gold deposits cover an area of 4 sq. miles. The most important of these from the point of view of longevity and total production is the Imotai field.

The Imotai and Minabaru fields lie adjacent to one another, while the Arwapai field lies some ten miles to the south and within 6 miles of the Old Pigeon Island workings of the Aranka goldfield.

Fourteen miles north-west of the Imotai workings are the gold deposits of the Tinambo field, near Kokerit.

History and Production

The goldfields of the Imotai were discovered by Culpepper, Carty and Benjamin in 1905. The development which ensued was largely due to Farnum and Smyth. In the period 1906 to 1909 11,521 oz. of gold were produced. With exhaustion of the richer deposits, production fell off rapidly, the total production from 1909 to 1912 being 1,945 oz. From that date to the end of 1937 the total production is recorded as only 619 oz. The discovery of the "Arawapai" or upper Kutuau field in 1937 led to an immediate increase of output, amounting to 240 oz. in 1938 and 450 oz in 1939.

The average annual production of the Imotai field may be estimated at some 400 oz. of gold, and that of the upper Kutuau at about 300 oz., a total of some $20,000 worth of gold annually (at $30 per oz. raw gold).

Arawapai Goldfield

This small but rich field was discovered by Theodore La Rose of Acquero in 1937 in the course of prospecting southwards from Arawapai Mouth. There are signs of much earlier prospecting in the southern portion of the field which probably extended from the Kopang, but had not reached the auriferous area. The field probably owes its late immunity from prospecting to its remoteness and difficulty of access.

The gold is often coarse, small nuggets of a few pennyweights being found, and rich pockets occur in the bedrock clay. Values of about $1.00 per yard overall appeared to be usual.

In view of the limited size of the known field, prospecting work was undertaken to extend the area. In the absence of any indication as to the probable direction of extension, radial lines were cut and thoroughly examined. Results were obtained on one line only, that cut south-south-east from near 12 miles on the Arawapai trail. Here good to fair values were obtained in gullies and creeks over a distance of about 2 miles. The discoveries were communicated to the men then working in the area and it has since been reported that workable deposits have been proved along this zone. The proximity of the field to the Old Pigeon Island goldfield was also made known and prospecting of the discoveries previously made by the Survey west of this locality was recommended.

Of the other lines cut and prospected by the Survey, low to fair values were obtained in creek heads on the north-east line from La Rose's Camp, and erratic occurrences of coarse gold were found on the north-west line from 7½ miles on the Arawapai Trail. These were also reported to the men working in the locality.

In the already-known auriferous area attention was paid to the possibility of hill-deposits occurring near the gold-bearing creeks. Intensive prospecting was carried out on the hillsides adjoining La Rose's and Cox's workings, but no values were found. It seemed possible that some of the alluvial gold might be derived from an

auriferous gravel at the base of the White Sand Series, but the absence of gold generally in the hill alluvials alongside the workings makes this unlikely. Small float fragments of quartz showing visible gold had been found in Cox's workings but the source of the quartz has not been determined.

The gravels consist of coarse to fine angular quartz, often tourmaliniferous, with pebbles of partially decomposed greenish-grey tuffs, derived from the bedrock, and worn almond-shaped pebbles of quartz derived from the White Sand Series.

The general absence of workable values, apart from those described, to the north and north-east of the field is to be ascribed to the less pronounced incision through the White Sand Series of the upper Waini headwaters as compared with those of the Kutuau. Whereas the Kutuau headwaters have cut down for some 20 to 40 ft. into the bedrock, the Waini streams have only begun this incision and often their beds are still in the basal sands of the Series. Assuming, as seems most probable, that the gold is present as disseminations and in quartz stringers in the bedrock, its concentration into workable alluvials will depend on the volume of rock which has been worked over by the streams. In the case of the Kutuau headwaters, assuming that these have cut an average of 20 ft. downwards into the bedrock from the base of the sands, and having regard to the fact that little migration of gold from its source is practicable owing to the clayey nature of the bedrock, it can be calculated that values of 4 cents per cu. yd. in the bedrock will be sufficient to produce an alluvial deposit carrying $2.00 per cu. yd.

Imotai Goldfield

The most extensive workings of the field lie in the Big Hope (also known in its upper course as Hopeful) Creek and its tributaries.

Previous and present gold-workings are almost continuous along the valley of the Big Hope for a distance of 3 miles. The creek bed has been thoroughly worked throughout, and the operations of the diggers are now restricted to the flats. These have an average width of 600 ft.

Tributary Creeks

The area known as Bonanza lies in rugged country at the headwaters of Tiger Creek, a tributary of the Big Hope. It is reported to have yielded good returns in coarse gold; the ravines have been worked exhaustively and little ground of value now remains.

The source of the alluvial gold appears to lie in small quartz stringers in the hornblende-schists.

Minabaru Goldfield

Extensive old workings occur in the Minabaru and its small tributaries in and near a granite stock, mainly on its western contact with metamorphosed basic rocks.

The Minabaru is interrupted in the auriferous area by a number of small falls and rapids. Between these, the creek flats have been worked in clusters of pits, but a fair amount of ground carrying payable values still remains. Along the western contact of the granite, in the basic rock, several ravines have been worked up to their heads.

Minor Occurrences

Recent workings were encountered at 2 miles on the Survey's north line from 6½ miles on the Canister trail. They lie in a narrow valley cut through white sand deposits into mica-schist bedrock. Towards the head of the worked ravine, well foliated garnetiferous muscovite-granite is exposed, while the auriferous gravels contain, in addition, boulders of mica-schist, muscovite granite, and foliated hornblendic rock. Boulders of vein quartz, adhering to a hornblendic wall-rock, were also seen. The camp was deserted when visited and tests of the gravels alongside the workings showed no values. The gold won may have been coarse and its distribution erratic.

Within the Shararin stock, old workings occur in a small creek near 5 miles on the Canister trail. The workings are restricted to a short length of the creek and the gravel is shallow. Nearby are exposures of hornblende-granite and amphibolite. Tests of the unworked gravels gave poor results.

Old workings, also within the Shararin stock, lie close to the Waini River immediately above Haiari Falls. These were excavated chiefly in search of diamonds, but no workable concentrations were apparently found. Reworking some of the ground in the vicinity for gold was said to have been unsuccessful.

Coarse eyes of gold were found by the Survey in an unworked creek near 4 miles on the Canister trail. The values were low, but further prospecting should be carried out here.

Recent claim-boards were noticed near 6 miles on the same trail, in mica-schist country, but an examination of the ground was not feasible.

Good values in coarse gold were obtained in small creeks at 2¾ and 3 miles on the Survey north-west line from 7½ miles on the Arawapai Trail. There are no workings in this tract of country, and further investigation is recommended.

On the trail to the Maple Creek workings, erratic occurrences of coarse gold were noted in a rocky creek at 23½ miles. Further downstream the gradient of the stream diminishes and the flats here merit prospecting.

DIAMONDS

The occurrence of diamonds in the area is restricted to the Arawapai field, where occasional stones are found in the course of battel washing in the auriferous gravels, and to a sandy area immediately west of Haiari Falls, which is said to have yielded a few stones

some years ago. In both areas the diamond-bearing gravels contain well-worn quartz pebbles derived from the basal beds of the White Sand Series.

In the upper Kutuau, diamonds have not yet been found in workable concentrations. Jigging tests both by the Survey and the gold diggers, continued over long periods, yielded only occasional small stones, giving an incommensurate return for the labour involved. The size of the stones does not exceed about one-quarter carat. Water-clear stones, with some slightly tinted varieties, are usual, and the crystal form is usually well developed. The edges are sharp and unabraded.

The usual variety of concomitant heavy minerals or " indications" are found in the diamondiferous gravels, including staurolite, anatase, ilmenite, and quartz prisms.

Fair diamond " indications " were found in creeks at 4½ and 7 miles on the Arawpai Trail. These localities are in the vicinity of white sand deposits carrying thick water-worn gravels. In the time available sieve-jigging was not feasible, but it is desirable that such tests should be made here, as well as at other localities lying along the central line of the white sand belt.

Manganese

Greenish-black clays and boulders of friable low-grade manganese ore occur on a hill of 290 ft. elevation ¾ mile from the end of the G.S. north line cut from the falls in the Minabaru. The zone has a width of about 50 ft, striking roughly east-west, and occurs within cream-coloured sandy clays typical of the muscovite-granite and mica-schist country; an outcrop of fine-grained granite lies within 800 ft. and boulders of vein-quartz within 200 ft. of the occurrence.

The freshly fractured material of the manganiferous boulders has a minutely pitted and spotted appearance and soils the fingers. A thin section shows an opaque black ground mass of manganese oxide shot through with shreds and veinlets of quartz. Concentrates from the crushed rock include colourless garnets. The appearance of the rocks suggests that it was originally a manganese-garnet-quartz rock, the decomposition of the garnets in which has resulted in the production of a low-grade ore. It has similarities with the gondites described from the Barama.

Analysis of a sample gave a metallic manganese content of 10·3 per cent., present as acid-soluble oxide.

SUMMARY

Apart from the occurrence of extensive areas of mica-schist and muscovite-granite, the geological conditions are similar to those already described in the adjacent and other areas, viz., metamorphosed basic and acid to intermediate volcanic rocks intruded by batholiths and stocks of hornblende-granite, granodiorite and diorite. All are intruded by dykes and sills of dolerite. The basic

rocks form ridges of relatively high country, capped by lateritic ironstone, while the troughs between the ridges show the remnants of peneplaned surface on which isolated deposits of the White Sand Series occur.

Alluvial gold occurs and has been worked in three small fields over a total area of about 9 sq. miles. Its occurrence is closely related in two of the fields to the hornblende-granitic rocks. No workable deposits of auriferous quartz or mineralised bedrock are known in the immediate area. The results of prospecting work by the Survey indicate small extensions of the known fields.

No ground capable of supporting dredging operations is known, but there are in the Big Hope Creek of the Imotai goldfield about one million cu. yds. of ground which may carry sufficient values to justify large-scale hand working with the aid of pumps.

Auriferous quartz float occurs in the Arawapai field. The blanketing of a great part of this area with white sand deposits makes a specific search for quartz reefs difficult and any veins exposed in the course of alluvial workings should therefore be carefully examined.

Diamonds, not, however, in workable concentration, occur in association with water-worn gravels at the base of the White Sand Series.

Low-grade siliceous manganese ore occurs as a small deposit associated with muscovite-granite and mica-schist.

PROGRESS IN COLONIAL MINERAL INDUSTRY

MALAY STATES (FEDERATED)

The following data for the third quarter of 1940 have been compiled from returns furnished by the Chief Inspector of Mines.

PRODUCTION OF TIN-ORE
(July to September 1940)

State.	Metal content. (*Long tons.*)	Value. (£.)
Perak	13,787	3,571,564
Selangor	6,620	1,716,029
Negri Sembilan	660	170,999
Pahang	802	207,788
Total	21,869	5,666,380

Other minerals produced were: gold, 7,743 troy oz.; coal, 194,520 tons (all from Selangor); china clay, 108 tons; haematite, 279 tons (all from Perak); wolfram, 9 tons; scheelite, 18 tons.

MALAY STATES (UNFEDERATED)

Johore

The following progress report on mining in the State of Johore during the third quarter of 1940 has been compiled from a statement submitted by the Acting Warden of Mines.

Tin Ore.—The production of tin ore continues to be regulated by Tin Restriction and can only correspond to the permitted quota release plus an amount of tin ore sufficient to bring the stocks held at the mines to the full amount permitted under the International Tin Restriction Agreement. Exports cannot be greater than the permitted quota release for each quota period, which corresponds to a quarter of a year.

Exports of tin ore from all sources during the period under review amounted to 435·6 tons, valued at $700,097.68 as compared with 423·73 tons valued at $730,179·77 during the second quarter of 1940.

The proportion of the total exports of tin ore from mines owned or managed by Europeans was 61·26 per cent. during the third quarter of the year as compared with 60·8 per cent. during the second quarter.

Iron Ore.—Exports of iron ore for July amounted to 63,460·2 tons, for August 56,174·4 tons, and for September 52,072·05 tons, making a total export of 171,706·65 tons valued at $858,533·25. The exportation of ore from the East Coast was resumed during April, and from Endau the tonnage exported during the quarter amounted to 75,227·5. From Batu Pahat (West Coast) 96,479·15 tons were exported.

Bauxite.—The Kim Kim Mine, which is situated near Pulau Nanas on the south coast of Johore, was not operated during the quarter. From other mines the bauxite exported amounted to 12,813·32 tons, valued at $64,066·6, the whole of which went from Batu Pahat on the west coast.

Gold.—There was no production of gold during the period under review.

Trengganu

The following statistics of mineral output for the year 1940 have been received from the Commissioner of Lands and Mines, Trengganu.

Mineral Output for the Year 1940
(*Long tons*)

Quarter.	Tin Ore.	Wolfram.	Iron Ore.
January-March	152	44	44,850
April-June	125	60	387,500
July-September	131	40	424,775
October-December	151	44	252,590
Total for year	559	188	1,109,715

Practically the whole of the iron ore was produced by two Japanese companies.

NIGERIA

The following information covering the third quarter of 1940 has been supplied by the Chief Inspector of Mines.

MINERAL PRODUCTION AND EXPORTS, JULY-SEPTEMBER 1940

	Production.	Exports.
	Tons.	*Tons.*
Tin ore . . .	4,439	5,748*
Columbite . .	94·9281	—
Wolfram . . .	23·6576	19·4376
	Troy oz.	
Gold (900 fine) .	7,519·81	—

* *Customs figures of ore shipped during the quarter.*

Tin.—At the beginning of the quarter notification was received that, for the following 12 months to June 30, 1941, the quota would be 130 per cent. of Standard Tonnage, consequent upon certain trade arrangements made with the United States of America.

Licences were issued for the 6 months ending December 31, 1940, and increased production commenced at once. Exports in the first month of the quarter were 2,800 tons of ore. In August they were only about one-fifth of that amount, but rose again to over 2,000 tons of ore in September. Stocks, however, were maintained in spite of the greater exports, and the quarter closed with 83 tons more on hand than at the end of June. The total of 5,726 tons of ore exported during the quarter was 1,088 tons in excess of the proportionate quota for that period, so that Nigeria was well in advance with the balance of her 1940 shipments.

Gold.—Production in the third quarter showed an increase compared with the two previous quarters, but was still some 880 oz. less than during the corresponding 9 months in 1939.

Columbium.—No columbium was shipped during the quarter but production continued with a slight increase.

Tungsten.—Production and export was practically the same as in the second quarter.

ABSTRACTS AND NOTES

Tungsten Mining in Nigeria.—Although it has been known for many years that wolframite occurs in the Nigerian tinfields, and there was a small output during the Great War, production was not officially recorded until 1934 and was very small until the second half of 1938. Since then, however, wolframite veins have been opened up in several districts and in 1939 a total of 240 tons of concentrates was produced. The output declined during 1940 as in some cases there was reluctance to install permanent equipment after the easily-won ore of the early discoveries had been worked out, but unless tungsten prices fall the industry may be expected to continue.

Cassiterite, columbite and wolframite belong to the same primary

mineralisation in Nigeria, but whereas the two former are worked almost entirely from alluvial deposits, wolframite is only obtained from vein deposits and adjacent eluvium, as it does not persist under alluvial conditions. Only some of the localities where wolframite is found have as yet been described, but it appears that they are principally on the northern edge of the main tinfield. The production of wolframite concentrates by provinces during 1939 was as follows: Bauchi, 159 tons; Zaria, 53 tons; Kano, 24 tons; and Plateau, 4 tons.

The following notes on some of the deposits are taken largely from the *Nigerian Mines Department Annual Report* for the year 1939. In Bauchi Province in the district around Kalato, about 60 miles north of Jos, several cassiterite-wolframite lodes have been exposed with strikes totalling more than 3 miles. This district includes the former alluvial workings of the Yarde Kerri Group and a large part of the production there has been won by the Nigerian Tin and Exploration Co., Ltd.

At Liruen Kano in the southern part of Kano Province, about 20 miles west of the Kalato District, the Liruen main lode has now been opened up by opencast mining for over 3 miles along the strike. This is a well-defined lode in the younger granite and was described in *Bulletin No.* 11 *of the Geological Survey of Nigeria.* The lode strikes east-west and passes through the properties of four mining companies controlled by two groups. The lode gives a concentrate consisting roughly by weight of 50 per cent. cassiterite, 40 per cent. wolframite and 10 per cent. sulphides. There is considerable variation along the lode. The denudation of upper portions of this lode can be considered the source of alluvial tin in the neighbourhood and what is left is the root of the original lode. With a strike of over 3 miles it may still persist for a considerable depth.

Mining consists of working lode outcrops by opencast. The ore is crushed by hand and panned, and the wolframite separated with magnetic separators. Experimental parcels of this concentrate have been treated successfully in England by the Murex process.

Mica in Tanganyika.—During the period 1918-1920 Tanganyika produced 150 tons of sheet mica valued at £400,000. In view, therefore, of the heavy British and American demands for mica of munitions grade at the present time and the limited number of occurrences of such material, the recent review on "Mica in Tanganyika Territory," by G. J. Williams and A. F. Skerl (*Bull. No.* 14, 1940, *Geol. Div. Tan. Terr. Dept. of Lands and Mines*), from which the following abstracts are taken, is of topical interest.

Mica was discovered in the Uluguru Mountains in 1894, in which locality a survey made shortly afterwards revealed the presence of a considerable number of mica-bearing pegmatites, samples from which were reported upon as being of high quality. Two German companies, formed in 1902, produced mica regularly until 1910

when an amalgamation under the name of Ostafrikanische Bergbau and Plantagen Gesellschaft was formed. Operations, suspended at the outbreak of war in 1914, were recommenced under the direction of a British Military Board in 1917, but owing to the damage done to the mines and plant by the retreating forces, it was not possible to make shipments until 1918. When the Government ceased to control the industry in 1920, the mines and claims were disposed of to private interests and the industry saw a considerable expansion until 1925, after which it gradually sank to a low level, particularly during the 1931-1934 trade depression. An improvement in market conditions has, however, recently led to a revival of the industry and particularly of underground exploitation of mica in the territory.

The mica deposits in Tanganyika are found exclusively in pegmatites which usually intrude the orthogneisses and paragneisses of the Lower Basement Complex System (Archaean). In the case of the Sibwesa occurrence, however, the country-rock is of a schistose rather than a gneissose character. The pegmatites, which vary from a few inches up to 100 ft. or more in width, are generally characterised by high dips (rarely more than 5° to 10° from the vertical) by sharp contacts with the country rocks and by the absence of contact metamorphism. Although there is no evidence as to the downward persistence of these pegmatites, it is believed that no serious pinching-out in depth is likely to occur, but in view of the sporadic distribution of the mica, haphazard cross-cutting cannot be employed as a means of prospecting.

The principal mica localities of the Territory are in the Morogoro district, in the Kaguru-Nguru-Kwanandu region, in the Rubeho mountains, and in the Usambara region, in addition to others in the south-eastern and south-western parts of the Territory. Owing to its superior quality and its accessibility to the railway and coast, mica from the eastern zone in the Lower Basement Complex has always been the most important in the Territory, but, with improved transportation, mica from areas formerly less accessible may assume greater importance in the near future.

Of the above occurrences, that in the Uluguru mountains south of Morogoro is the most important from the point of view of production, and in this area the Mkinha-Viragule pegmatite zone has been most intensively developed both by surface and underground workings at three mines located at Chibao, Mkinha and Viragule, all of which produce green mica which in normal times was consigned to Germany.

The pegmatites, which strike in a general north-south direction, occupy a well-defined fault-fracture zone cutting across the gently-swinging strike lines of the augen paragneiss. It is claimed that in this particular field only those steeply-dipping pegmatites which hade eastwards bear mica of commercial quality, but this has not been checked by the Survey.

In other parts of the Uluguru mountains a considerable number of other mica occurrences are known, but in these the structural features are by no means so regular as in those described above, and according to this report none of the mines are working at the present time on either the western or the eastern side of the Uluguru mountains. It is said that the practice of working the mica bodies to the limits of opencast operation has militated against the optimum economic exploitation of the body as a whole by aggravating the water problem when subsequent underground operations have been attempted.

The second important mica-producing area in the Territory is on the north-western side of the Kaguru and Nguru mountains, and from the deposits in the Kisitwe and Kitangi neighbourhoods there is a steady output of ruby mica. In this area the pegmatites dip steeply to the north-west and strike roughly north-east to south-west, generally cross-cutting the granitic biotite-orthogneiss at right angles.

Other occurrences of mica are known in many parts of Tanganyika, but most of them are dormant at the present time with the exception of that located about a mile south-south-west of the Winza mine in the Rubeho mountains. The mica from this occurrence is notable on account of its exceptional size, but this is, unfortunately, offset by its waviness and only quite small "books" are actually available for the market.

Although the entire production of mica from Tanganyika Territory is of the muscovite variety, there has recently been a discovery of phlogopite from which a trial shipment has been made. Mention also may be made here of the occurrences in Tanganyika of the micaceous mineral vermiculite (previously noticed in this BULLETIN, Vol. XXXVII, No. 1, p. 122 and No. 2, p. 277) which are described in some detail for the first time in this report. The lithium mica, lepidolite, is also known to occur in Tanganyika, but the quantities as yet known are insufficient to warrant their commercial exploitation.

A feature of mica mining in Tanganyika is the relatively small amount of capital invested in the industry, a state of affairs which will need serious revision as the necessity for underground operations becomes more pressing with the depletion of the readily accessible surface deposits. Attention will also have to be given, it is pointed out, to the exploitation of the existing dumps for splittings and ground mica.

The expense incurred in the preparation of this survey of the mica deposits of Tanganyika has largely been defrayed by the Colonial Development Fund.

Crocidolite in the Cape Province.—Asbestos is one of the minerals for supplies of which the world is primarily dependent upon the Empire, and crocidolite or blue asbestos is produced on a large

scale only in the Cape Province. Blue asbestos is of particular importance because of its use in marine insulation.

In the Cape it occurs in cross-fibre seams in the banded ironstones of the Lower Griqua Town Series of the Transvaal System. The most elaborate operations have taken place on the farm Westerberg, where the outcrops of a synclinal deposit occur on either side of a valley. An account of operations on this deposit by W. E. Sinclair appears in *Bull. Inst. Min. Met.*, No. 437, February 1941.

The strike tends to follow a semi-circle but is interrupted by a number of faults causing displacement. The mine has therefore been divided into nine sections which facilitates systematic exploitation. The dip is steep, apart from local flattening.

Two methods are adopted for the exploitation of the mine, a contract system and company work. The former accounts for about 40 per cent. of the total output and 75 per cent. of the hand-cobbed fibre produced. Under this system a native miner is provided with tools but purchases his own explosives and lighting materials and pays his own helpers underground and cobbers on the surface. Payment depending on the nature of the ground and length of haul varies from 10*s*. to £1 a foot for development work, and 2*s*. to 3*s*. per foot advance in stoping off a 5 ft. to 6 ft. "lift." Contract work is usually measured up monthly when the fibres of $\frac{3}{4}$ in. and under are cleaned and graded on a three-decker shaking screen into three grades: A, $\frac{1}{2}$ in. to $\frac{3}{4}$ in.; S, $\frac{1}{4}$ in. to $\frac{1}{2}$ in.; and X, less than $\frac{1}{4}$ in. Fibres longer than $\frac{3}{4}$ in. do not usually need screening.

Shrinkage stoping is used and theoretically all waste is left as filling, although in fact about 20 per cent. of the ground broken is excess waste and is extracted. The face is carried horizontally in lifts of 5 to 6 ft. which facilitates measurement and the winzes are usually placed not more than 60 to 100 ft. apart. The waste rock is used for stone-walling so that no timber is required.

Stoping advance amounts to 0·775 ft. per boy-shift, which corresponds to just under one ton per boy-shift in an average 36 in. stoping width, at an average cost of 1*s*. 9*d*. per ton. The average recovery of fibre by contractors from stoping is at the rate of 44 lb. per boy-shift.

In recent years the company has introduced a new system to overcome the fall in output by contractors due to the deepening of the workings. Development work has proved the continuation of the reef to about 450 ft. on the dip and the presence of substantial ore reserves of good quality. It is now being carried out on two levels with raises and winzes to prove the ore reserves of the three reefs. These form "backs" of about 150 ft. and are used later for stoping. The cost of development which is carried out by jack-hammers averages from 17*s*. 9*d*. to 19*s*. 6*d*. a foot for various classes of work.

The choice of the stoping system depended on various factors which included the steep dip of the reefs with occasional flattening

or reverse dip, the narrow stoping width, the dryness and dustiness of the workings, the absence of any serious problem of ground support except local scaling, sorting operations, and the varying character of the reef face. Two forms of stoping have been adopted of which the most useful is overhand shrinkage rill stoping. The ore is sorted after every blast and lowered down the waste filling in skips with runners. The face is at an angle of 45° to the level above so that the filling lies at its natural angle of repose. Stope faces are drilled on alternate days so as to give a complete shift for sorting, but even so 40 per cent. of the ore is covered by waste filling and is sorted out when the filling is withdrawn above ground. Total mining costs average 4·9s. per ton.

Underhand open-breast stoping is more costly and is only suitable in narrow stoping widths where there is no false hanging wall to need timbering, but it is more efficient and gives an immediate 100 per cent. ore recovery.

Grading by the standard testing machine employed for chrysotile in Canada has not been found feasible for crocidolite and the following classification summarises the grades:

Name.	Class.	Length.
X or SS . .	Shorts	Less than ¼ in.
S	Mill grade	¼ in. to ½ in.
S	Hand-cobbed	¼ in. ,, ½ in.
A	,,	½ in. ,, ¾ in.
B	Long hand-cobbed	¾ in. ,, 1¼ in.
C	,, ,,	1¼ in. ,, 1¾ in.
D	,, ,,	1¾ in. ,, 2 in.
E	,, ,,	Over 2 in.

All ore except that carrying long fibre is fed to jaw-crushers for primary breaking to minus ½ in. It is then delivered through inclined shaking screens to rolls set to ⅛ in. aperture and thence to 100-mesh screens to remove dust. The ore then passes along a conveyor belt to the disintegrator which revolves at 1,500 r.p.m. and is fitted with manganese-steel beater arms. Any liberated long fibre is removed on the belt. From the disintegrator the product passes to double-decker shaking screens. The dust passes to dump while short fibres are removed for separate treatment as an X grade. The longer fibres pass to another set of screens similarly operated by eccentrics causing the fibre to flow up to the higher end where it is drawn off as Mill S grade. The undersize joins the X grade fibres for retreatment.

The ratio of the two grades recovered is about 9 of S to 1½ of X and the total fibre recovery from the ore varies from 13·78 per cent. to 26·7 per cent. The capacity of the mill is about 2 tons of ore an hour and the cost 3·73s. per ton.

The S and X grades are sent to Prieska for further treatment which includes cleaning, grading and blending the long fibres into A, B, C, D grades, and the mechanical mixing of hand-cobbed S grade with the milled S grade. The average output of different grades is as follows: X, 7·15 per cent.; S, 81·02 per cent.; A,

6·72 per cent.; B, 4·37 per cent.; C, 0·60 per cent.; D, 0·14 per cent.

The Iron Ores and Iron Industry of Western China.—The principal iron ore reserves of the former Chinese Empire lay in Manchuria and in the lower Yangtze valley, and these deposits formed the basis of the modern iron and steel industries of China and Manchuria. With the transference of the Chinese Government to Chungking the iron ore resources of Western China have become of national importance for the first time. Tegengren's standard work, "The Iron Ores and Iron Industry of China" (*Mem. Geol. Surv. China Series A, No. 2*, 1921-23), contains references to scattered deposits of iron ores in Szechwan, Kweichow and Yunnan Provinces, but as these were little known and only used in primitive native smelters no estimate of the reserves was given. Recently Chinese geologists and economists have made intensive studies of the mineral resources of Szechwan Province and part of eastern Sikang, and some of their results have been reported in *Mineral Trade Notes*, Vol. II, No. 4, October 19, 1940.

Data on the iron ore reserves are still scanty, but according to recent estimates the reserves in Szechwan Province total 145 million tons. Presumably this does not include the Province of Sikang where known reserves are estimated at 23 million tons. For specific localities, however, estimates are available only for deposits in the Kikiang district of Szechwan, and for three districts in Sikang.

Kikiang (Ch'i-Chiang) is situated some 45 miles south of Chungking, and river transport to the capital is available by the Kikiang river and the Yangtze. The reserves of the Kikiang district total 13,867,000 tons comprising the Tutai deposits 7,896,500 tons, the Talopa deposits 4,148,000 tons and the Maliupa deposits 1,822,500 tons. The Tutai (T'u-Tai-Chang) deposits consist of some three veins ranging in thickness from 1 to 2 ft., although veins up to 4 or 5 ft. thick have been worked. Tegengren described the best ore as haematite containing about 50 per cent. iron, but added that the ore often contained as much as 2 to 3 per cent. of sulphur.

In Sikang Province, in the valleys of the Yalung and Anning rivers, some of the richest deposits in Western China are reported to occur. The reserves of three districts are estimated to total 22,960,000 tons; 7,216,000 tons in the Mienning district, 10,584,000 tons in the Hweili district, and 5,160,000 tons in the Yenyuan district. These deposits are said to consist almost wholly of magnetite and haematite with an iron content ranging as high as 71 per cent. in some instances. It may be that the high figures for both reserves and content are due to inadequate surveying of the deposits because of their remoteness. This region is separated from Szechwan, in which it was formerly included, by high mountain ranges, and from the economic point of view is linked by trade routes with Kunming (Yunnan-fu).

Iron smelting in Szechwan probably dates back to the seventh century B.C., and primitive native smelters producing wrought iron and some pig iron supplied the bulk of the iron requirements of the Province until quite recently. Steel is also manufactured from this native iron by a kind of cementation process. Estimates of the annual production of iron from native furnaces range from 20,000 to 30,000 tons. Kikiang is now the most important centre of this industry, there being 25 smelters with an annual output of 5,900 tons in that district, and there are also several smelters in the Weiyuan, Kiangpei and Tungliang districts.

The Chinese Government's efforts to build up iron and steel industries in Szechwan appear to be meeting with some success. In Chungking alone there are the plants of the China Industrial Corporation (a merger of the Union Iron and Steel Works, the China Radio Corporation, and the mining division of the West China Development Corporation), the Ta Hsing Iron and Steel Works, the Hua Hsing Machine Works and the Yu Hsing Iron and Steel Works, as well as smaller plants. Equipment of the Hanyehping plant at Hankow was removed to Szechwan after the fall of that city, and the machinery is being installed in several plants now under construction. Included in the equipment were two 100 ton blast furnaces, two 250 ton blast furnaces, and two 30 ton Martin furnaces. The iron and steel division of the China Industrial Corporation is equipped with one 30 ton blast furnace, one 15 ton blast furnace, one 10 ton open hearth steel furnace, one 1 ton Moore electric furnace, and one Merchant rolling mill, and the mining division operates an iron mine and three coal mines. The daily capacity of blast furnaces now operating is 185 tons of pig iron, and a conservative estimate for the production of iron in Szechwan during 1940 from both blast furnaces and native smelters is between 50,000 and 60,000 tons. In all probability, however, new blast furnaces were put into operation during 1940, and the present production may be considerably more.

From the foregoing data it would seem that no basis exists for a large iron and steel industry in Szechwan. Further, the plants now being erected are all too small to be economical in operation, but the keen demand for iron and steel in Western China, stimulated by the shortage of imported supplies, may enable the new industries to expand sufficiently for economical operation.

The most hopeful location seems to be in the vicinity of Chungking, where there is river transport and easy access to the Kialing coalfields and the Kikiang iron-ore deposits. The latter appear to be the only deposits of any immediate economic significance.

Determination of the Hardness of Mineral and other Substances by Micro-indentation.—Considerable progress has been made during recent years in the determination of the hardness of various substances by means of minute pyramidal diamond-indenters attached

Hardness of Minerals and other Materials*

Material.	Hardness on Mohs' Scale.	Hardness on Proposed Extension of Mohs' Scale.	Diamond Pyramid Hardness. (*Kilog./mm².*)
Plasticine			0·02
TALC	*1*	*1*	*3*
Graphite (soft) . . .			3
Pitch			5
Celluloid			14·5
Rock Salt			15
Coal—			
Durain			21
Cannel			22
Vitrain			22
Anthracite			40
Bearing metals—			
Medium tin alloy (Pb 29%, Sb 9%) . .			23 Mass hardness
Lead base alloy (Sn 11%, Sb 13%) . .			25 Mass hardness
Tin base alloy (Cu 5%, Sb 10%) . .			30 Mass hardness
GYPSUM	*2*	*2*	*32*
Ferrite—			
Very pure iron . .			50
Ordinary			85
Wrought iron (0·23% P) .			125
Pearlite—			
Spheroidal (0·8% C) . .			130
In malleable cast-iron .			300
CALCITE	*3*	*3*	*135*
FLUORITE	*4*	*4*	*163*
Beryllium bronze (4% Be)—			
Cast			189 Mean H_D
Quenched			353 Mean H_D
Tempered			447 Mean H_D
APATITE	*5*	*5*	*360-430*
Sorbite (0·8% C) . . .			400
Flint glass		-	400
Crown glass			450
Fused quartz			475
Albite			500
Troostite (0·8%) . . .			500
ORTHOCLASE	*6*	*6*	*550*
Vitreous pure silica . . .		*7*	*625*
QUARTZ	*7*	*8*	*680*
TOPAZ	*8*	*9*	*750*
Garnet		*10*	*800*
Fused zirconia . . .		*11*	*850*
Martensite (0·8% C) . .			900
"Carboloy"			950
Emerald			1,000
CORUNDUM	*9*		*1,200*
Fused alumina		*12*	*1,200*
Alundum			1,450
"Widia" tungsten carbide .			1,450
"Firthite" sintered carbides			1,750
Silicon carbide . . .		*13*	*1,800*
Boron carbide (moulded) .		*14*	*2,000*
DIAMOND	*10*	*15*	*7,500*†

* *Materials indicated by Roman capital letters refer to the standard minerals of Mohs' Scale; those indicated by italics are the proposed sub-divisions of this Scale (See Ridgway, Ballard and Bailey, "T. Electrochem Soc.",* 1933, **63**, 369).

† *Author's suggested standard pyramid hardness. The observed hardness by means of the Knoop Tester is* 8,300 *Kilog./mm².* (*See Knoop, Peters and Emerson, U.S. Journ. of Research,* 1939, **23**, 39.)

to special objectives of measuring microscopes. The testing operation consists essentially of lowering the indenter until the loading system reaches a suitable value as viewed in an appropriate eyepiece, after which the microscope is refocused and the size of the indentation is measured. The hardness is expressed as applied load in kilograms divided by the area of the indentation in sq. cm.

Various micro-indentation testers have been described from time to time, the Zeiss Tester, for instance, having a small diamond pyramid 0·8 mm. wide fixed to the front lens of the " objective," which consists of two parts held together by two parallel disc ring-springs. On screwing down the main tube of the microscope, the indenter presses into the test specimen, and causes a deformation of the disc springs which is registered on an internal scale by means of an auxiliary self-contained objective. The image of the scale moves within the eyepiece by an amount which is a measure of the load exerted on the diamond : the scale itself may be pre-set to the desired load by the adjustment of an external ring.

The development of so-called micro-indentation methods has been discussed by Dr. Hugh O'Neill in an article entitled " The Hardness Testing of Micro-Specimens, Micro-Constituents, and Minerals," recently published in *Metallurgia* (1941, **23**, No. 135, pp. 71-74). The above table showing the hardness of various substances has been compiled from data either contributed by the author himself or quoted by him, in which case full references are given. The observed hardness value for diamond is about 12 million lb. per sq. in.

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

EMPIRE MINERAL RESOURCES AND THEIR RELATION TO THE WAR EFFORT. By Sydney J. Johnstone. Twenty-third Streatfeild Memorial Lecture, 1940. Pp. 85, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Institute of Chemistry, 1941.)

Frederick William Streatfeild lectured at the City and Guilds of London Finsbury Technical College from its foundation in 1883 until his death in 1918, and the students trained by him passed to many varied walks of applied chemistry. In appreciation of his tutelage and guidance, a foundation in the form of a series of memorial lectures was formed, the first of which was given by the late Sir Wm. Pope, F.R.S., in 1918. These annual lectures, which are all delivered by Streatfeild's former students, have covered a wide range of topics, among which may be mentioned photography, sugar, quinine, rubber, beer, opium and magnesite.

In August 1940 the author of the present lecture, who is the Principal of the Mineral Resources Department of the Imperial Institute, gave a talk at the House of Commons to the Parliamentary and Scientific Committee on the subject of Empire mineral resources in relation to war needs, and as a result of a suggestion by the Streatfeild Memorial Committee that this might be amplified and published for the benefit of a wider audience, the twenty-third of this series of lectures has now appeared under the above title. For this lecture the author has since received the Streatfeild Memorial Medal presented by the Governors of the City and Guilds of London Institute.

The mineral wealth of the Empire is conveniently considered under the following four broad headings based upon the extent of Empire self-sufficiency. The minerals of the first group are those which we possess in abundance: asbestos, celestite, china clay, chrome ore, columbite and tantalite, diamonds, gold, ilmenite, mica, nickel, platinum metals, tin and zircon. The second group, consisting of minerals of which we have ample supplies with an exportable surplus, includes cadmium, cobalt, coal, fluorspar, fuller's earth, graphite, gypsum, lead, manganese, monazite, radium, salt, silver, vanadium and zinc. The third group comprises minerals in which we are slightly deficient and contains arsenic, bauxite, barium minerals, bismuth, copper, diatomite, felspar, iron ore, magnesite, phosphates, rutile, talc and tungsten. The fourth group is made up of those in which we are almost completely deficient, namely, antimony, borates, mercury, molybdenum, petroleum, potash, pyrites and native sulphur.

This degree of self-sufficiency is further amplified in the paper by a series of useful graphs and tables illustrating the actual Empire production of these minerals and the percentage which this constitutes of the world production. These are reproduced on pp. 75 to 79.

Of interest to those who are directly concerned with our present effort is the comparison which the author draws between our position at the outbreak of the present hostilities with that in which we found ourselves in 1914, pointing out our generally improved situation in supplies of petroleum and in the ores of copper from Northern Rhodesia and Canada, lead from Australia, Canada and Burma, and of zinc and nickel, at the same time drawing attention also to our increased smelting, refining and reduction capacity for treating these natural products. Specially interesting in connection with the deficiency minerals is the bringing into production since the last war of potash from Palestine, mercury from Canada and South Africa and pyrites from Cyprus.

Following this review of the strategic aspects of the mineral wealth of the Empire, the author proceeds to consider in more detail the production, trade in and uses of the principal minerals and metals of commerce, dealing in turn with the mineral fuels, the

iron and ferro-alloy minerals, the minerals of the base and precious metals, precious stones, minerals for chemical industry, the industrial earths and clays, and miscellaneous non-metallic minerals.

There has been a notable development, particularly within the last few years, of active participation by Empire Governments in fostering the search for and even aiding in the preliminary stages of exploitation of minerals, and the stimulus thus given to the finding of new deposits and to the development of existing ones is of particular interest and importance at the present time. The author concludes his paper, therefore, with a brief resume of a comprehensive survey of this Government assistance to our mineral industry which is being prepared at the Imperial Institute. It is hoped that this survey will be more fully described in a subsequent issue of this BULLETIN than is possible within the limits of the present lecture.

This lecture will doubtless prove invaluable to all those who are interested in the manifold problems relating to the production, trade in and uses of the principal mineral raw materials of the Empire.

TABLE I

*World and British Empire Outputs of the more important Minerals for 1935 and 1938 in Approximate Order of Value.**

Minerals.	1935			1938		
	World Total.	British Empire Total.	Empire Percentage.	World Total.	British Empire Total.	Empire Percentage.
	Long tons	*(thousands.)*		*Long tons*	*(thousands.)*	
Coal	1,310,000	288,000	22·0	1,420,000	304,000	21·4
Petroleum	225,000	4,020	1·8	271,000	6,740	2·5
Gold (*fine oz.*) (*thousands*)	*29,600*	*17,040*	57·6	*37,300*	*21,200*	56·8
Iron ore	140,000	17,950	12·8	165,000	21,520	13·0
Copper ore (metal content)	1,470	410	27·9	2,020	600	29·7
Tin ore (metal content)	136	59	43·7	160	64	40·0
Silver (*fine oz.*) (*thousands*)	*223,000*	*37,200*	16·7	*267,000*	*48,400*	18·1
Lead ore (metal content)	1,370	545	39·8	1,780	631	35·4
Zinc ore (metal content)	1,540	454	29·5	1,840	550	29·9
Salt	31,000	5,300	17·1	32,000	5,200	16·3
Potash (K_2O equivalent)	2,470	13	0·5	2,900	32	1·1
Phosphates	10,000	868	8·7	12,400	1,322	10·7
Sulphur	2,400	124	5·2	3,500	152	4·3
Nickel ore (metal content)	76	63	83·3	113	95	84·2
Pyrites	8,000	450	5·6	10,000	1,124	11·2
Diamonds (*metric carats*)	*6,190*	*2,501*	40·4	*11,456*	*3,418*	29·8
Asbestos	369	255	69·1	500	344	68·8
Manganese ore	4,100	1,200	29·3	5,800	1,870	32·2
Bauxite	1,760	146†	8·3	3,990	634†	15·9
Chrome ore	780	235	30·1	1,100	408	37·1
Mica	35	8	23·7	31	10	33·8

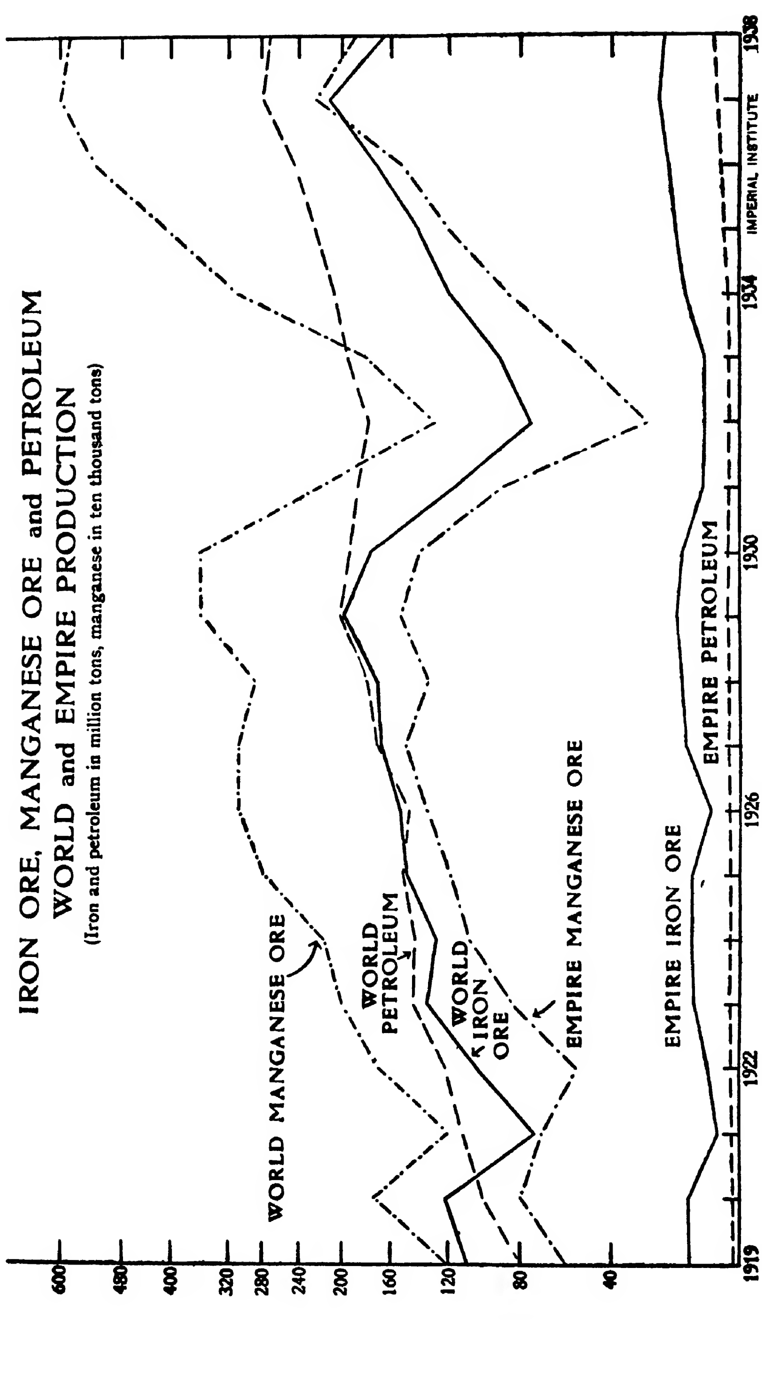
* *Allowance has been made in the World Total for 1938 outputs in U.S.S.R., Japan, Spain and certain other countries for which complete data are not available.*

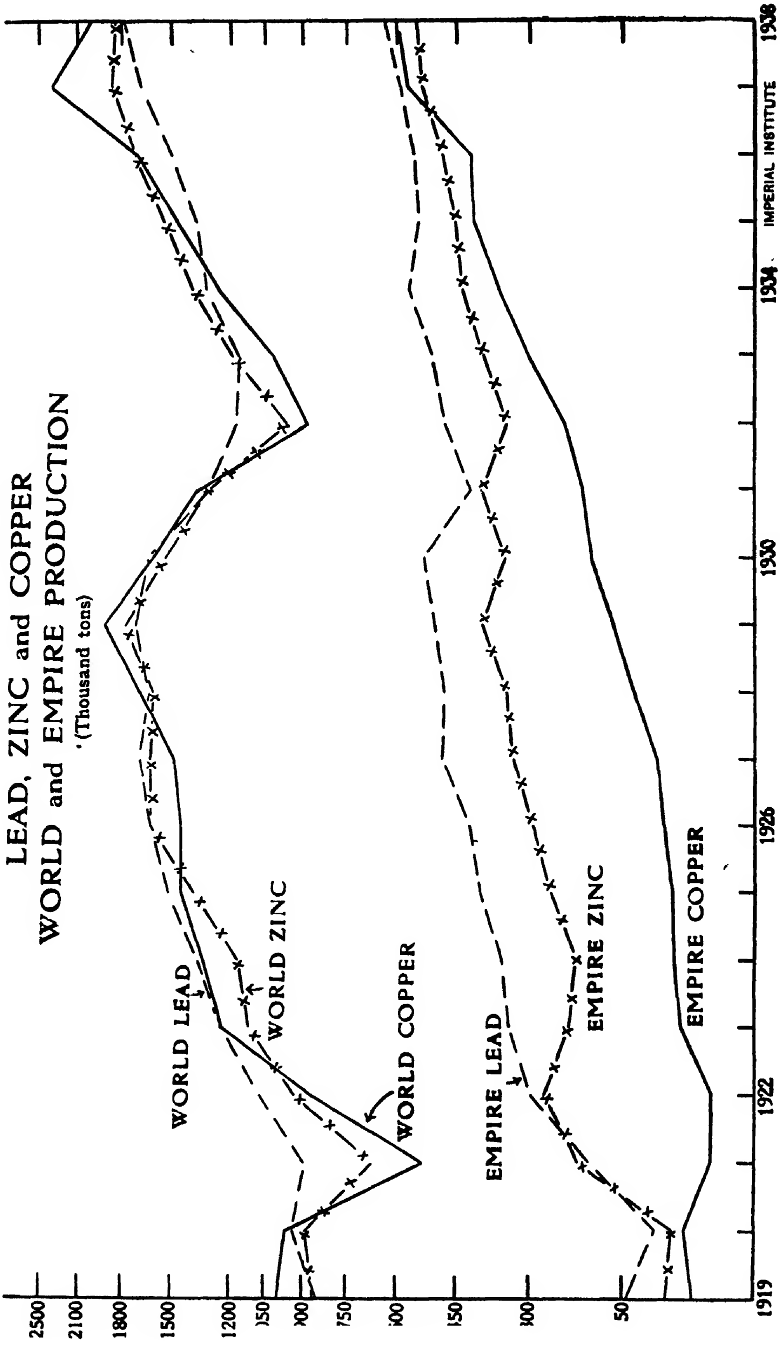
† *Includes ore (30-50 per cent. alumina) placed on dumps, 25,000 tons in 1935 and 116,000 tons in 1938.*

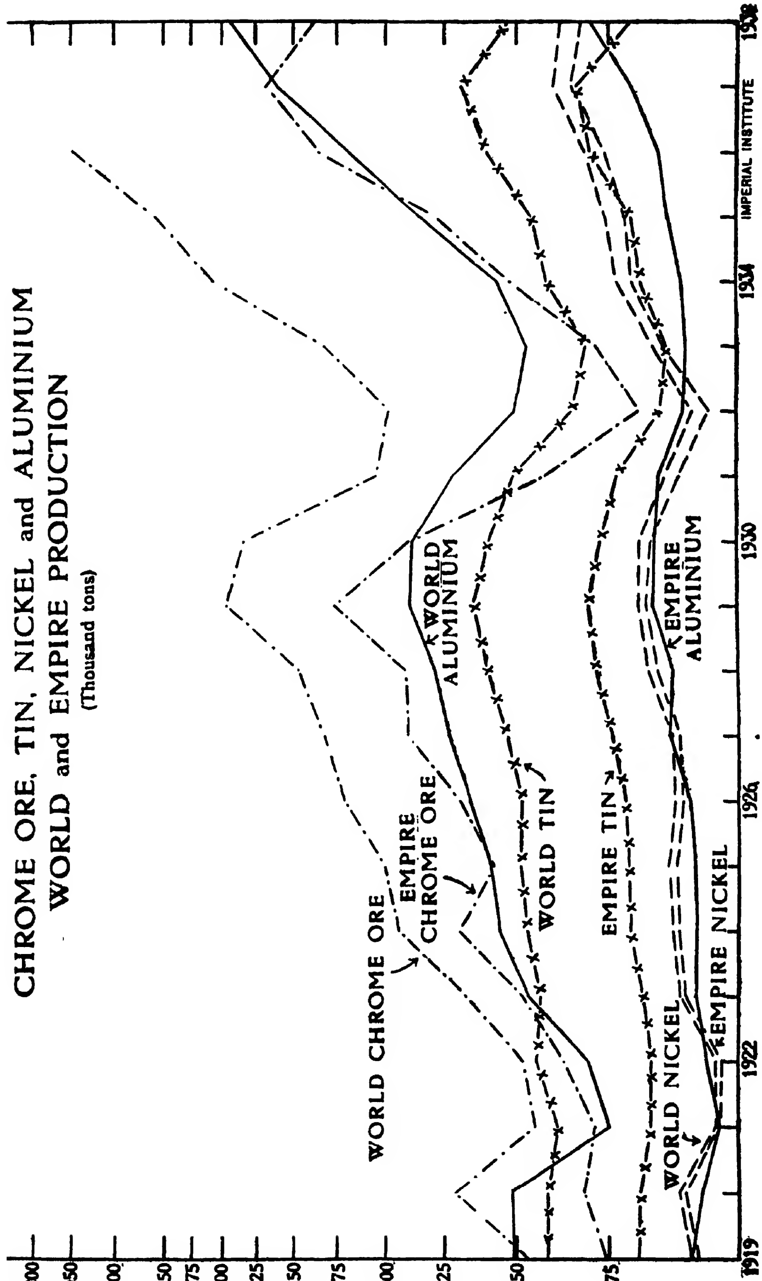
TABLE II

Value of the British Empire Mineral Output during 1938

Country.	Value (£ sterling) (thousands).	Percentage of Empire total.	Chief minerals produced. Figures show percentage value of the country's output.
United Kingdom	214,979	41·57	Coal, 87·8; building and road material, 7·6; iron ore, 1·6.
Union of South Africa	98,790	19·10	Gold, 87·7; coal, 4·8; diamonds, 3·5.
Canada	89,656	17·34	Gold, 37·6; copper, 12·8; nickel, 12·2; coal, 10·0; lead, 3·2; zinc, 2·7; asbestos, 2·9; silver, 2·2; natural gas, 2·6; petroleum, 2·1.
Australia	29,900	5·78	Gold, 37·4; coal, 20·2; silver-lead-zinc, 15·4; iron ore, 6·9; copper, 2·1.
India	18,051	3·49	Coal, 44·8; manganese ore, 16·6; gold, 12·8; petroleum, 7·0; mica, 4·8; salt, 4·0.
Northern Rhodesia	10,684	2·07	Copper, 83·2; cobalt, 12·8; vanadium, 2·4.
Federated Malay States	8,460	1·63	Tin, 88·9.
Southern Rhodesia	7,696	1·49	Gold, 75·6; asbestos, 13·3; coal, 6·2; chrome, 3·1.
Burma	7,417	1·43	Petroleum, 50·8; lead, 16·5; tungsten, 8·2; tin, 7·9; silver, 6·9.
Gold Coast	6,220	1·20	Gold, 76·6; manganese ore, 14·6; diamonds, 8·8.
New Zealand	3,224	0·62	Coal, 55·4; gold and silver, 30·2.
Trinidad	2,751	0·53	Petroleum, 96·0.
Nigeria	1,920	0·37	Tin, 87·9; gold, 9·2.
Newfoundland	1,720	0·33	Iron ore, 50·5; copper concentrates, 17·3; lead concentrates, 15·8; zinc concentrates, 15·3.
Sierra Leone	1,684	0·33	Diamonds, 48·6; iron ore, 38·4; gold, 12·9.
New Guinea	1,580	0·33	Gold and silver, 100.
Unfederated Malay States	1,505	0·29	Iron ore, 61·1; tin, 30·4.
Cyprus	1,495	0·29	Copper concentrates, 51·4; cupreous pyrites, 32·7; asbestos, 5·9.
South West Africa	1,444	0·28	Diamonds, 53·8; copper-lead ores, 29·7; vanadium, 11·9.
Other British Empire	7,900	1·53	Gold, 32·6; petroleum, 24·7; phosphate rock, 11·4.
	517,000	100·00	


IRON ORE, MANGANESE ORE and PETROLEUM
WORLD and EMPIRE PRODUCTION
(Iron and petroleum in million tons, manganese in ten thousand tons)
WORLD MANGANESE ORE
WORLD PETROLEUM
WORLD IRON ORE
EMPIRE MANGANESE ORE
EMPIRE IRON ORE
EMPIRE PETROLEUM
600
480
400
320
280
240
200
160
120
80
40
1919
1922
1926
1930
1934
1938
IMPERIAL INSTITUTE


LEAD, ZINC and COPPER
WORLD and EMPIRE PRODUCTION
(Thousand tons)
WORLD LEAD
WORLD ZINC
WORLD COPPER
EMPIRE LEAD
EMPIRE ZINC
EMPIRE COPPER
IMPERIAL INSTITUTE
2500
2100
1800
1500
1200
750
50
1919
1922
1926
1930
1934
1938


CHROME ORE, TIN, NICKEL and ALUMINIUM
WORLD and EMPIRE PRODUCTION
(Thousand tons)
WORLD CHROME ORE
EMPIRE CHROME ORE
WORLD ALUMINIUM
EMPIRE ALUMINIUM
WORLD TIN
EMPIRE TIN
WORLD NICKEL
EMPIRE NICKEL
1200
1050
900
750
675
600
525
450
375
300
225
150
75
1919
1922
1926
1930
1934
1938
IMPERIAL INSTITUTE

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EXHIBITION GALLERIES, FILM LIBRARIES AND CINEMA

NOTES

Exhibition Galleries.—The Galleries remain closed to the general public as a temporary war measure but are open to inspection by inquirers and other persons interested.

On January 15 the Director welcomed Col. the Rt. Hon. Sir Reginald Dorman-Smith, the Governor Designate for Burma, and accompanied him on a tour of the Burma Court and afterwards to the Cinema where he was shown Burma colour-films taken by Lady Cochrane.

On February 5 the Secretary of State for India and Burma and Mrs. Amery, accompanied by Lady Dorman-Smith and Mr. J. Clague, Adviser to the Secretary of State for Burma, were received by the Director and Lady Lindsay and after a tour of the India and Burma Courts paid a visit to the Cinema where they saw Lady Cochrane's colour-films of Lord and Lady Linlithgow's visit to Rangoon, Pagan and Mandalay, the Governor's durbar at Taungyi and leg-rowing on Sule Lake.

On the morning of January 27 Major Geoffrey Miller, Military Secretary to the Governor Designate of Burma and Mrs. Miller paid a visit to the Imperial Institute and were welcomed by the Director. They made a detailed inspection of the Burma Court and saw some of Lady Cochrane's colour-films of Burma. Later on the same day Major Miller again called and received from the Director some illustrated pamphlets and literature descriptive of Burma.

On February 20 and again on February 22 Lieut. E. T. Cook, Aide-de-camp to the Governor Designate of Burma, visited the Burma Court and saw films of Burma.

On February 12 the Director received His Excellency Col. J. T. M. Welter, Colonial Minister of the Netherlands Government, who was accompanied by Dr. G. H. C. Hart, Director of the Economic Division of the Ministry of the Netherlands Colonies. They made a tour of the Courts in the South and East Galleries and afterwards saw films in the Cinema.

On February 24 the Director received His Excellency Richard Brunot, Governor-General of the Free French Colonies, together with officers on the Staff of General de Gaulle, Commandant Escarra, Dr. Guéron, Monsieur Lenormand, Monsieur Mathieu and Monsieur

Monod. The visitors were shown over the India and Burma Courts and later saw a display of coloured films in the Cinema, followed by refreshments in the Pavilion.

By arrangement with the British Council, programmes were arranged for the following visits to the Galleries during February and March. On each occasion the party was met at the entrance to the Institute and was conducted through the Exhibition Galleries, after which a display of films was given in the Cinema.

Friday, February 14.—Dutch Mercantile Marine Officers.

Sunday, February 16.—Belgian visitors, most of whom belong to the offices of the Belgian Government in London.

Saturday, February 22.—Norwegian visitors, including members of the Norwegian Youth Association.

Wednesday, February 26.—A party from the Czecho-Slovakian Refugee Trust Fund.

Thursday, February 27.—A party from the British Czecho-Slovakian Centre.

Saturday, March 1.—A party from the Czecho-Slovakian Refugee Trust Fund.

Thursday, March 6.—A party from the Czecho-Slovakian Refugee Trust Fund.

Saturday, March 8.—A party of Dutch civilians from the Netherlands Emergency Committee.

Sunday, March 9.—A party of foreign visitors from the Hampstead Refugee Centre.

Monday, March 10.—A party of Belgians from the Paddington War Refugee Committee.

Saturday, March 15.—A party from the Czecho-Slovakian Refugee Trust Fund.

Saturday, March 29.—A party from the Czecho-Slovakian Refugee Trust Fund.

On February 22 the Exhibition Galleries formed the venue for one of the weekly meetings of the London Appreciation Club. The thirty-one members who attended under the leadership of their secretary, Mr. Leonard Peers, were welcomed by the Director, and after a conducted tour of the Canadian Court witnessed in the Cinema a display of Empire films, after which the party was entertained to a buffet tea. On March 8 this Club paid a second visit and on this occasion made a tour of the East Gallery, visiting the Courts of India, Burma and Ceylon.

New Exhibits.—Despite the difficulty of procuring exhibits and new samples of products from overseas in these abnormal times, some progress has been made in carrying out the programme for improving the displays of staple products in the Cyprus Court. As an introduction to the story exhibits life-size model sprays of

certain economic plants have been introduced. These models were made in the Imperial Institute Studio by Mr. A. J. Carter and their accuracy of detail and natural colouring have been made possible largely through the kind co-operation of the authorities of the Royal Botanic Gardens, Kew, who generously provided living material to work from. The models so far installed comprise a spray of the carob tree (*Ceratonia siliqua*) bearing unripe beans, which at this stage are green and less familiar to visitors than the mature brown locust beans, which are also shown in association with the model; a spray of Cyprus oranges, of the Jaffa type, showing flowers and an early stage in the development of the fruit as well as fully ripened oranges; a spray of the olive tree bearing ripe purple fruits, also sprigs to show what the flower of the olive is like, and mature but green olives such as are used for preserving; and a branch of the grape vine showing black grapes that may at choice be used as table grapes, for wine making, or dried and made into raisins.

Such models as these not only serve to impress on the minds of students the botanical sources of familiar products, but they are also very attractive to the man-in-the-street and to children who are always interested in seeing " how things grow."

Further progress has been made in the rearrangement of exhibits in the New Zealand Court. A centre showcase formerly occupied by the phormium fibre exhibit has been fitted with a central partition, on one side of which has been displayed the more important of New Zealand's minerals and on the other the story of kauri gum. The kauri gum display, comprising photographs and specimens, has been arranged in three sections which deal respectively with (1) gum obtained from the growing kauri tree, (2) fossil gum as formerly obtained by probing in the soil, (3) samples of the material as it is procured to-day by digging and hand sieving or mechanical washing. This display is completed by specimens of linoleum in the manufacture of which the gum resin is now largely used.

The New Zealand phormium fibre exhibit has been rearranged in a wall showcase so that the complete " story " may now be seen at a glance. Starting with a series of enlarged photographs depicting cultivation, harvesting the leaves, extracting the fibre and drying, the exhibit goes on to show by means of specimens and further photographs the successive operations such as hackling, drawing, spinning, stranding and laying in the manufacture of a 3-strand rope, a coil of which concludes the story.

Additional examples of phormium fibre manufactures are: 2-ply cord, lanyard, binder twine, hay band and a woolpack, this latter having the merit that there are no loose fibres to cause wool contamination. On the adjacent wall is shown a Maori cloak, made of hand-extracted fibre in pre-European days, obtained by Captain Cook about 1776 when voyaging in the Pacific.

A new exhibit has been added to the Borneo Court in the form of a Dyak parang presented for display by Mr. D. D. Daly, of

London. The weapon was given to Mr. Daly's father, the late Dominic Daly, an officer of the British North Borneo Company, in 1889 by a Borneo chief in token of friendship.

A set of 34 specimens of common commercial timbers, measuring about 9 in. × 4 in. × 1 in., has been received from British Malaya together with a Forest Service Trade Leaflet in which the uses of the individual timbers are described. The timbers have been displayed in the Malaya Court classified according to the leaflet in four groups: (1) naturally durable, heavy constructional timbers; (2) non-durable, heavy or medium heavy constructional timbers; (3) general utility woods; and (4) special purpose woods. Six additional timber specimens when available are to be despatched from Malaya to complete the set.

Imperial Institute Stories of Empire Products.—The series of Imperial Institute stories of Empire products to which reference was made in the last issue of this BULLETIN, p. 527, has been continued, three further posters having been prepared with descriptive leaflets to accompany them. A copy of No. I leaflet dealing with "Sea Island Cotton: the Story of a Shirt" was reprinted as Appendix A to the number of the BULLETIN referred to above; No. II deals with Uganda cotton seed and some of its everyday uses; No. III with Ceylon coconuts in everyday life; and No. IV with Trinidad lake asphalt for roads, roofs and insulation.

Central Film Library.—Since September 1, 1940, the name of the film libraries has been changed to the Central Film Library, incorporating the Empire and G.P.O. Film Libraries. On that date the Institute undertook the non-theatrical distribution of films produced for and acquired by the Ministry of Information. The Ministry has placed 50 16 mm. travelling projectors in various parts of the country and by the middle of March 1941 this number will have been increased to 75; it is also placing 50 16 mm. projectors in various public libraries; it is arranging special film shows in public cinemas; and it is lending copies of its films to organisations such as schools, technical colleges, literary societies and women's institutes which have their own projectors. The Central Film Library is responsible for the distribution of films in all these sections of the Ministry's schemes. The result of this arrangement is a large increase in the number of films available to the schools and other organisations which borrow films from the Empire and G.P.O. Film Libraries. By the end of January the Ministry had placed in the Library 2,000 16 mm. prints of 80 films and 200 35 mm. prints of 68 of these films for distribution to borrowers with their own projectors. The supply of films is being increased weekly.

In order to house these additional films and the additional staff and equipment necessary to carry out the increased work involved,

a new film store was added to the existing film store. Additional equipment, including a machine for cleaning films has been installed, and additional clerical and technical staff have been engaged. The Ministry of Information is providing the funds necessary to enable the Institute to carry out these increased responsibilities. The financial arrangements make it possible for all films now to be despatched from the Library carriage paid, and the borrower has only to pay the return carriage. The administration of the Central Film Library is controlled by the Director of the Institute, and the Ministry is represented at the Institute by one of the officers of its Film Division. The Institute is naturally gratified that its Library organisation should have been selected by the Ministry of Information to carry out this important national work, which may mark the beginning of still further developments of its educational work now and after the war.

Since the last notes appeared in this BULLETIN, 1940, **38**, 405, many new prints have been added in all sections of the Library. In the Empire section 228 prints have been received ; these included subjects already held and 35 entirely new subjects. Thanks are due to the British Council for 168 prints, to the Imperial Relation's Trust for 134 prints and to the Canadian Government for 14 prints.

Lectures.—In order to stimulate interest on the part of the rising generation in the history of the British Empire, its achievements and its objectives, the Institute organised, in co-operation with the Ministry of Information and the Board of Education, an experimental scheme for free lectures on Empire subjects to be given at primary and secondary schools outside the County of London, accompanied by displays of films and lantern slides from the Film and Lantern Slide Libraries of the Institute, in those schools where projectors or lanterns are available.

With the assistance of the Colonial Office and representatives in this country of Governments of the Overseas Empire and of various Empire organisations, the Institute has formed a panel of over 100 lecturers with first hand experience of the Dominions, of India or Burma, or of the Colonies.

Although the scheme only came into operation in June 1940, 216 lectures were given up to the end of December to audiences comprising nearly 35,000 persons, and during the last fortnight of January 17 lectures to audiences totalling 2,680 pupils were given. It is anticipated that during February and March the number of lectures and audiences will show appreciable increase. Very favourable reports have been received from schools in all parts of the country which have taken advantage of this service.

By this means the story of the Empire and all it stands for is told to the rising generation who are thus taught to realise the value of the Empire as a world-wide community of peoples, some of whom are already self-governing nations, or are rapidly advancing

towards equal partnership, while for the development of others not yet able to stand alone Britain accepts the responsibility of a trustee.

On Thursday, February 6, the Director opened a discussion at a meeting of the Henley Literary Society with an address on "The British Empire, Past, Present and Future," and on Friday, March 7, he addressed the annual general meeting of the Society of Public Analysts on the subject of "The Imperial Institute and its Services to the Empire."

Empire Lantern Slide Library.—The circulation of lantern slides of the Empire to schools, women's institutes and societies in the United Kingdom during the period November 1940 to January 1941 is shown in the following table:

Subject.	1940. November.	1940. December.	1941. January.
Canada	400	50	450
Australia	250	150	400
New Zealand	150	100	100
South Africa	50	50	50
India	550	150	400
Burma	200	100	100
Territories of Colonial Empire	500	400	1,100
Products of Colonial Empire	100	50	250
Tours of the Empire	50	150	50
History of the Empire	540	120	60
Total	2,790	1,320	2,960

The following new picture talks for circulation with slides were prepared during the three months ended January 1941:

The Madras Presidency	By R. D. Anstead, C.I.E., M.A.
South India and its Temples	Do. do.
Plantation Crops of India	Do. do.
Nilgiris and Malabar Coast	Do. do.
Burma Teak and Burmese Elephants	By M. Myat Tun, B.Sc.(Econ.).
Sarawak	By E. J. Parnell, Sarawak Civil Service (Retired).
Hong Kong	By G. S. Wilby, Hong Kong Educational Service.
Cyprus	By K. St. G. O. Wayne, Cyprus Commissioner.
Ceylon	By R. B. Naish, Ceylon Civil Service.

Colonial Visitors.—The following is a list of officers on leave from the Colonies, etc., who have visited the Institute during the three months November, December 1940, and January 1941:

NOVEMBER 1940

E. H. DUCKWORTH, Inspector of Education, Nigeria.
E. W. LEACH, Senior Agricultural Superintendent, The Gambia.
R. B. NAISH, Ceylon Civil Service.
A. F. W. SHEFFIELD, Agricultural Officer, Nigeria.

DECEMBER

Nil.

JANUARY 1941

Captain N. C. DENTON, Administrative Service, Nigeria.
Dr. F. R. IRVINE, Master, Achimota College, Gold Coast.
A. F. A. LAMB, Assistant Conservator of Forests, Nigeria.
H. R. MITCHELL, Senior Inspector of Mines, Nigeria.
A. L. MORRIS, Assistant Registrar, Lands and Mines, Tanganyika.
Captain E. C. NOTTINGHAM, M.C., Commissioner of Police, Gold Coast.
D. H. PEACOCK, Lecturer, University College, Burma.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see our Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

VOL. XXXIX. NO. 2. APRIL-JUNE, 1941

PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

HYPTIS SEED FROM NIGERIA AND THE SUDAN

Two samples of Hyptis seed have recently been examined at the Imperial Institute. One, sent by the Senior Assistant Conservator of Forests, Katsina, Northern Provinces of Nigeria, was identified at Kew as *Hyptis spicigera*, and the other, sent by the Director of the Agricultural Research Institute, Wad Medani, was labelled " *Hyptis spicigera* seed from Equatorial Sudan."

Hyptis spicigera Lam. is an annual plant, belonging to the natural order Labiatæ, and known in parts of West Africa as "Benefing" (=black sesame) and in the Sudan as " Kindi." It is a native of tropical Africa and is cultivated in some regions for the seed, which is used as a foodstuff like sesame seed. Brown and Massey (" Flora of the Sudan ") state that the seeds are reduced to a pulp by the Zindes and used as an adjunct to stews and gravies, and that they are also roasted and eaten or an edible oil is extracted from them.

The seeds have been recorded to contain from 21 to 37 per cent. of oil, which has good drying properties, and the samples received at the Imperial Institute were examined as oil seeds with the following results.

The sample from Nigeria consisted of very small oval seeds, brown to dark brown in colour and having an aromatic odour. The seed from the Sudan was similar in shape and size but was buff coloured.

The moisture and oil content of the seeds were as follows:

	Sample from Nigeria. *Per cent.*	Sample from Sudan. *Per cent.*
Moisture	5·6	7·3
Oil in seed as received	20·5	29·1
Oil in moisture-free seeds	21·7	31·4

In each case the oil was golden-yellow in colour and resembled linseed oil in odour. The constants of the oils are given in the following table in comparison with the analytical figures for raw linseed oil as stated in the British Standard Specification No. 632 (1935):

		Sample from Nigeria.	Sample from Sudan.	Limits for Raw Linseed Oil (B.S.S. 632).
Specific gravity at 15/15° C.		0·9346	0·9338	0·931-0·936
Refractive index at 20° C.		1·4835	1·4829	1·4800-1·4835
Acid value		6·8	0·9	not more than 4
Saponification value		191·8	193·1	not less than 188
Iodine value, Wijs, 1 hr.	*per cent.*	205·8	202·0	not less than 175
Unsaponifiable matter	*per cent.*	1·59	1·34	not more than 1·5

The examination of the oils showed that the constants of that from the Nigerian seed mostly fall within the limits laid down in the British Standard Specification for raw linseed oil, whilst the oil from the Sudan seed still more closely resembles linseed oil.

Hyptis oil therefore comes within consideration as a possible substitute for linseed oil and other drying oils such as tung oil. Before its value for this purpose and its commercial prospects can be stated it will be necessary to conduct trials to ascertain whether the commercial expression of the oil can be successfully carried out. Technical trials with the oil and feeding trials with the residual cake are also necessary.

The oil content of the Nigerian seed, viz., 20·5 per cent., is rather low, that of linseed being commonly about 35 per cent. The Sudan seed is more satisfactory in this respect (29·1 per cent.), but it will be necessary to ascertain the yield of oil actually obtained under commercial conditions.

There is normally a good demand for drying oils, but unless Hyptis seed is available in such amounts that regular supplies of the oil in commercial quantities can be ensured, it would not be worth while carrying out the trials mentioned above. If the oil can only be produced in small quantities it might find a useful outlet locally. On this aspect of the matter Dr. J. D. Tothill, Director, Agriculture and Forests, Sudan, has sent the following communication to the Imperial Institute: "The value of this very generally grown food crop in Yei District and other parts of the South is likely to be for its local value as human food rather than for export as a paint oil. However, the possibility of export cannot at this stage be ruled out and an opportunity will present itself in due course to send a commercial sample when an oil press has been installed."

INCENSE GUMS FROM BRITISH SOMALILAND

THE exports from British Somaliland consist principally of animal products (sheep and goat skins, livestock and ghee), the only plant products of domestic origin exported being gums and resins. The latter consist in the main of aromatic gum-resins such as frankincense, myrrh and bdellium (see this BULLETIN, 1914, **12**, 11-27). With a view to improving the quality of the incense gums an investigation was commenced by the Imperial Institute in 1938 in collaboration with Mr. E. F. Peck, the Chief Veterinary and Agricultural Officer, British Somaliland, one of the principal subjects of investigation being the cause of the " blocking " of the gum during transit. In connection with this work seven samples of incense gums were forwarded to the Imperial Institute by the Chief Veterinary and Agricultural Officer in January 1939, together with one sample of " blocked " gum sent at his request by a trading company.

The following are the particulars of the seven samples received from the Chief Veterinary and Agricultural Officer as supplied by him :

Incense " Gum " Mohor (Boswellia carteri)

" *Fusus.*"—Large white pieces of good " gum " formed when the rains have ceased and the drying " khariff " wind blows.

" *Nugas.*"—New " gum " of low quality. Not sold alone, but mixed with better " gums."

" *Habak Daired.*"—Brown sticky exudate formed when rains recommence.

" *Foh.*"—" Gum " (not necessarily Mohor) from a former year together with bark cleanings and other gum rubbish.

Incense " Gum " Maidi (Boswellia frereana)

" *Firtoh.*"—At about the eighth tapping of the tree smaller pieces of gum are obtained, whilst " alwah " is forming underneath. About four or five tappings are made.

" *Korib.*"—First six or seven tappings of watery exudate, and gum droppings scraped from the ground under the tree.

" *Alwah.*"—Large pieces of " gum " formed underneath " firtoh."

Description of Samples

I. Mohor (*Boswellia carteri*).

Fusus.—Opalescent tears varying in size from $\frac{1}{8}''$ diameter up to about $1\frac{1}{4}'' \times \frac{1}{2}'' \times \frac{1}{2}''$, and stalactitic pieces up to $1\frac{1}{2}'' \times 1'' \times \frac{1}{2}''$, having a dull whitish exterior. Colour of tears and pieces variable,

some pale yellow, others dark reddish-amber and intermediate shades. A few tears possessed a greenish tint. The material was moderately soft and brittle, the paler pieces being rather softer than the darker pieces. The sample was free from extraneous material.

Nugas.—This material was somewhat darker than Fusus and there were pieces up to 2″×1″×1″ in size. Some conglomerate masses of tears were present. Fracture similar to Fusus. The sample was almost free from extraneous matter.

Habak Daired.—Generally similar in colour to Nugas, though darker pieces were more numerous. Some conglomerate masses of tears were present, and the sample contained some fragments of bark. On the whole the material was rather softer than the above two samples.

Foh.—This sample consisted chiefly of pale to dark brown bark varying in size from fine powder and small fragments to pieces 2½″ × 1¼″ × ⅛″. Some of the gum-resin was adhering to a few of the pieces.

II. Maidi (*Boswellia frereana*).

Firtoh.—Consisted generally of pieces smaller than Korib up to 1½″ × 1″ × ¾″. Mostly paler in colour, being largely yellow and a few pieces almost colourless. White oxidised crust was more pronounced, and in a few cases was as much as $\frac{1}{16}$″ in thickness. The material was rather more sticky and softer than Korib. A small amount of bark was present. As in the case of Korib the whole was loosely compacted together to form a single block.

Korib.—Small tears, fragments and powder mixed with larger pieces up to 2″ × 2″ × 1½″ which had become loosely compacted to form one large block. The colour was pale yellow to dark amber. The sample possessed a slight oxidised crust. The smaller pieces were generally translucent or almost transparent. The material was brittle though rather sticky, and almost free from bark and other impurities. Compared with Mohor samples this material was mostly considerably harder.

Alwah.—The pieces comprising this sample were generally larger than those in Firtoh and were mostly up to about 2½″ × 1″ × ¾″ with a few larger pale-coloured stalactitic pieces measuring up to 5½″ × 1½″ × 1″. The sample was very sticky and softer than that of Firtoh, although it was not compacted quite to the same extent as the above two samples. A small amount of bark was present.

The sample of *Blocked Gum* received from the trading company consisted of a single conglomerate resinous mass composed of pale and dark-coloured tears and fragments cemented together. Towards the exterior the material gave a brittle fracture though it was moderately soft, and was not sticky. Internally, however, the lump was very soft and sticky.

Results of Examination

The samples were examined with a view to determining differences in their composition, and the causes and prevention of the "blocking" of the incense gum during transit. The results are shown in the following table:

	Mohor (*Boswellia carteri*).				Maidi (*Boswellia frereana*).			Blocked Sample.	
	Fusus.	Nugas.	Habak Daired.	Foh.	Firtoh.	Korib.	Alwah.	Soft inner portion.	Harder outer portion.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	4·7	4·2	4·5	5·2	0·8	0·7	0·8	10·4	5·4
Volatile oil	9·4	8·6	6·9	1·7	8·5	4·5	10·3	8·0	7·8
Insoluble in alcohol (dirt + gum)	23·7	23·4	25·3	43·5	3·3	4·3	3·6	19·5	22·1
Insoluble in water and alcohol (dirt + insoluble gum)	2·0	5·1	7·7	34·2	1·8	3·6	1·9	5·3	4·4
Water-soluble gum + other soluble matter (by difference)	21·7	18·3	17·6	9·3	1·5	0·7	1·7	14·2	17·7
Resin soluble in alcohol (by difference)	62·2	63·8	63·3	49·6	87·4	90·5	85·3	62·1	64·7

From a study of the above table it will be seen that the samples of Mohor (*Boswellia carteri*) furnished similar analytical figures with the exception of grade Foh which consisted largely of bark. The sample of Fusus, however, yielded somewhat more volatile oil and contained a little more soluble gum than the samples of the grades Nugas and Habak Daired. The three grades of Maidi (*B. frereana*) yielded about the same sum total of volatile oil and resin, but as anticipated the softer the sample the more volatile oil it contained.

When comparison is made between the analytical results obtained for the samples of *B. carteri* and those of *B. frereana* it will be observed that they vary considerably, the most striking difference being that the samples of *B. carteri* contain considerable amounts of water-soluble gum, whereas the *B. frereana* samples are almost free from gum. As might be expected the product containing the most water-soluble gum would retain the most moisture, and thus the *B. carteri* samples contained from five to seven times as much moisture as those of *B. frereana*.

Judging from the analysis of the present samples the difference in the composition of the exudations from these two species of trees is such that only that from *B. carteri* can be truly designated a gum-resin or gum-oleo-resin; the product of *B. frereana* being practically free from gum would be classified as an oleo-resin of the elemi type, and not an incense gum.

It will be seen that in the examination of the blocked sample, which was conducted in a similar manner, representative portions

from the exterior and interior of the sample were investigated separately, and that the analytical figures corresponded with those obtained for the above sample of *B. carteri* resin. These results, taken in conjunction with the general appearance, odour and other properties of the material, showed that it was evidently derived from the species named, which is stated to yield the bulk of the exports of " gum " from British Somaliland.

Moreover the analytical figures obtained as the result of the examination of the inner and outer portions of this blocked sample would appear to have provided the required information regarding the cause of the blocking of the material. It will be conceded that a condition of softness and stickiness in a gum or resin would necessarily induce such blocking. Thus it was considered that the analysis of the soft and harder portions of the present material would show differences in their composition which would throw light on the cause of this trouble. The suggestion which had been made that the blocking may be attributable to differences in the volatile oil content is not supported by these analyses, which show that both the soft and the harder portions contained about the same amount of volatile oil. The opinion previously expressed by the Imperial Institute (in a letter to the Chief Veterinary and Agricultural Officer dated August 9, 1937) and more recently by a trading company that the cause of the blocking is due to insufficient drying of the gum-resin before packing for shipment is however fully substantiated, for it will be seen that the soft gum-resin from the interior of the sample contained about twice as much water as that taken from the exterior of the sample. The soft and sticky nature of the interior of the sample is therefore not due to the presence of an excessive amount of volatile oil in combination with the resinous constituents, but to an excess of moisture in contact with the gummy portion of this gum-resin.

The results of this investigation seemed to show clearly that the blocking of the true incense gum, *B. carteri*, was attributable to excess of moisture in the material, and it was therefore thought desirable to re-examine in this connection the present samples of the Fusus and Nugas grades of this gum-resin. As recorded above, these two samples were in the form of free tears and small conglomerate lumps, and were shown to contain 4·7 and 4·2 per cent. respectively of moisture. Definite weights of each of these samples were placed in glass-stoppered bottles, and the moisture content of each sample was very gradually increased by the addition of water until the total amount added was brought up to the percentage of moisture found in the soft inner portion of the blocked sample, namely 10·4 per cent. During the experiment the contents of the bottles were kept more or less in continual agitation, and the duration of the operation extended over some days to permit of the thorough absorption of the water. The results of this experiment showed that the addition of water to

the extent of increasing the moisture content to 5·4—the figure obtained for moisture in the harder outer portion of blocked resin—produced no effect on the general appearance and behaviour of the gum-resin; but on the gradual addition of further amounts, the previously freely-moving material in each bottle became more and more cohesive, until with the maximum of 10·4 per cent. of water the whole contents of the bottles adhered fairly firmly together to form a conglomerate " block."

The results of this investigation therefore fully confirm the opinion previously expressed that the trouble caused through the blocking of the true incense gum, *B. carteri*, during transit is due to the material being insufficiently dried before being packed.

Market Values

Samples of the materials examined were submitted for commercial valuation to two firms represented on the Imperial Institute Consultative Committee on Gums and Resins. The reports received were as follows:

(1) " Under present conditions in Europe (April 1939) we regret we cannot recommend consignments as the sale would be very uncertain, but the nominal values of Gum Mohor (*a*) Nugas, (*b*) Fusus and (*c*) Habak Daired respectively, are in our opinion about 30*s*.-40*s*., 45*s*.-50*s*., and 20*s*.-25*s*. per cwt." Regarding the samples of Gum Maidi, the firm reported: " Such qualities we think may prove quite unsaleable in this market as we have shown them to most likely buyers who tell us that they are of no interest whatever at any price. If it were possible to find a buyer, the values might be somewhere in the neighbourhood of 35*s*.-40*s*., 30*s*.-35*s*. and 20*s*.-25*s*. for Alwah, Firtoh and Korib respectively."

(2) " These samples I have carefully examined and can only repeat what I said at the last meeting, that unfortunately Gum Olibanum is no longer an article of any consequence in the market here. Business done is only a few cases at a time. I give you the nominal values as follows:

' *Fusus*.'—This is quite a good sample of the Aden quality, similar, I think, to what I saw a sample of at the last meeting. Nominal value, say, 55*s*.

' *Nugas*.'—Is about 45*s*.

' *Habak Daired*.'—About 30*s*. to 35*s*.

' *Foh*.'—No value.

' *Korib*,' ' *Firtoh*,' ' *Alwah*.'—I do not think this is Gum Olibanum, and I thought at first they might do for varnish work, but I submitted samples to some of the people in the trade and they have tested it, but cannot find that they contain properties like Gum Copal or Kauri, or any other varnish gum. Therefore, I should say it is no use going further into the matter."

In view of the poor report on the "Maidi" gums ("Korib," "Firtoh" and "Alwah"), inquiries were made in British Somaliland as to the purpose for which these gums are used locally. The Institute is informed that the gum is shipped almost exclusively to Egypt for making sweetmeats of the Turkish delight kind.

PINUS HALEPENSIS OLEO-RESIN FROM CYPRUS—II

THE two samples which are the subject of this report were forwarded to the Imperial Institute by the Conservator of Forests, Cyprus, in February 1940. They represented oleo-resin collected from trees grown in the Paphos Forest in connection with experiments that are being conducted with a view to the commercial exploitation of the product, and were described as (1) resin from old mature trees, and (2) mixed resin from the Stavros experiment. A report on an earlier sample of *Pinus halepensis* resin from Cyprus was published in this BULLETIN, 1938, **36**, 157.

The samples were similar in general appearance and odour to that previously examined. Sample No. 1 was of a rather more fluid consistency somewhat paler in colour, and contained less extraneous matter (consisting mostly of fragments of bark) than Sample No. 2. Both showed rather less impurities than the earlier sample, the approximate amount being as follows:

	Bark and other impurities. *Per cent.*
Sample No. 1 . . .	0·3
Sample No. 2 . . .	0·6
Previous sample . . .	1·0

The two samples, on distillation with steam, gave the following yields of oil of turpentine, as compared with the earlier sample:

	Yield of oil. *Per cent.*
Sample No. 1 . . .	20·9
Sample No. 2 . . .	19·3
Previous sample . . .	18·8

Oil of Turpentine.—Laboratory examination of the two oils gave the following characteristics:

Oil from.	Specific Gravity at 15·5/15·5° C.	Optical Rotation α_D.	Refractive Index $N_{D}20°$ C.
Sample No. 1 .	0·8674	−28·00° at 23° C.	1·4700
Sample No. 2 .	0·8682	−17·15° at 23° C.	1·4712
Previous sample .	0·8717	−17·5° at 22° C.	1·4724

The oils were subjected to fractional distillation with the following results, which are corrected to a barometric pressure of 760 mm.:

Oil from.	Proportion distilling		
	Between 152° and 160°C.	Between 160° and 170°C.	Above 170° C.
	Per cent.	*Per cent.*	*Per cent.*
Sample No. 1 . . .	60	31	9
Sample No. 2 . . .	56	32	12
Previous sample . .	55	33	12

The results for the present samples are in agreement with those for the earlier one, which was found to consist principally of laevo-α-pinene.

The proportions of residue remaining after evaporation on a water bath at 100° C. were:

Oil from.	Residue *Per cent.*
Sample No. 1	1·0
Sample No. 2	1·5
Previous sample . . .	3·2

In order to meet the requirements for Oil of Turpentine Type I of the British Standards Institution, not less than 95 per cent. of the oil must distil below 170° C. at 760 mm. pressure, and the residue after evaporation on a water bath must not exceed 2·0 per cent.

Rosin.—In the case of each sample, the rosin remaining after the removal of the oil by steam distillation, containing the impurities present in the original sample, was purified by extraction with ether. The clear rosins so obtained were compared with a set of type samples of American rosin issued by the United States Department of Agriculture. That from Sample No. 1, which was the paler of the two, corresponded to American rosin grade "I," and that from Sample No. 2, like the clear rosin obtained from the earlier sample, corresponded to American rosin grade "G."

On heating, using the open tube method, the rosins from both samples softened at about 68° C. and became semi-fluid at about 98°-100° C. Similar properties were shown by the rosin obtained from the earlier sample and also by a sample of American rosin.

The rosins furnished the following acid and ester values, which are shown in comparison with the corresponding figures for the rosin obtained from the earlier sample and with those recorded for American rosin:

	Acid value.	Ester value.
Rosin from Sample No. 1 .	175·8	9·1
Rosin from Sample No. 2 .	173·5	8·4
Rosin from previous sample .	177·7	4·7
American rosin . . .	152-177	up to 30

The rosin obtained from both the present samples was, as in the case of that prepared from the previous sample, completely soluble in alcohol, acetone, benzene, and oil of turpentine, and only partially soluble in a 10 per cent. solution of caustic soda.

Remarks

The examination of these additional samples of *Pinus halepensis* oleo-resin has furnished results generally similar to those obtained for the previous sample, and shows that this Cyprus product yields a laevo-rotatory oil of turpentine consisting principally of α-pinene, the predominant constituent of commercial American oil of turpentine, and a rosin or colophony similar in character to the American product. It will be observed that the oleo-resin collected from old mature trees contained a rather smaller amount of extraneous matter, and yielded a somewhat higher percentage of oil and a paler coloured rosin than either the mixed oleo-resin of the Stavros experiment or the sample examined previously. The age and diameter of the pine trees have long been held to have an important bearing upon the yield of oleo-resin, which usually increases until the tree reaches the age of about 60 years. The yield of oil varies with the efficiency of the method of collection, and the extent to which evaporation and oxidation have taken place through exposure. The present practical distillation experiments indicate that oil of turpentine from sample No. 1 contained a somewhat higher percentage of pinene than the other samples, and that this sample gave the lowest and most satisfactory evaporation residue.

ARTICLE

WAR-TIME DRUG SUPPLIES AND EMPIRE PRODUCTION

PART II

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Cultivation

It is well to bear in mind that the cultivation of drug plants is not always comparable with the growing of food crops and that entirely different problems may often be involved. In the case of food crops it is generally speaking the plant's natural food storage—in the seed, tuber, rhizome, etc.—that man requires, and cultivation aims at ensuring a good yield by developing this to a maximum extent. The valuable constituents stored up are limited to a few well-defined compounds, such as starch, sugars, proteins and fats,

the quantitative estimation of which is comparatively simple. Moreover, good yield normally is associated with healthy, luxuriant growth, and, above all, the conditions necessary to secure this have been well studied and worked out with most food plants.

Our understanding of these conditions as applied to medicinal plants is, however, still very incomplete. The active principles which make the plants of value as drugs are often of extremely complex nature and belong to the most varied chemical groups. What use these substances are to the plant is somewhat problematical and little is known of the way in which they are formed, but it is believed that in many cases they arise as waste products from the physiological processes going on in the living cells. As such they cannot be excreted by the plant but must be stored up in some convenient form. It is known that their composition and relative abundance in the plant tissues can be vastly affected by minor differences in climate and soil conditions, and that factors favouring sturdy growth of the plant do not necessarily favour the development of a high content of active principle, indeed, the converse is often true, as in the case of Chinese rhubarb. As an additional difficulty the quantitative estimation of many of these active substances is so difficult as to be quite impracticable as a routine matter, while for some drugs, such as cascara, biological tests give the only really reliable method of evaluation. This has led to the adoption in trade of convenient criteria for the evaluation of certain drugs, based on external characteristics and not necessarily bearing any relation to medicinal activity. Such standards, which have arisen in the first instance through lack of anything better, are often slow to go when accurate, scientific methods of evaluation are later developed.

There are then three main considerations involved in the cultivation of drug plants: (1) satisfactory growth of the plant (governing quantity of yield); (2) conditions favourable to development of a high content of active principle (governing quality); and (3) market requirements as to appearance and external characteristics. Unfortunately there are few drug crops in which the detailed cultural requirements comprising (1) and (2) have been properly studied, and this lack of knowledge is a great handicap. As a general guide, however, the grower's wisest course is to reproduce as far as possible in his choice of site and cultural operations the climatic and soil conditions under which the plant grows wild. Factors such as the provision of shade and shelter belts, which in turn affect atmospheric humidity are of importance, and where frost is a likely danger the question of air drainage should be taken into account in choosing the site. Soil conditions are often of first-rate importance, particularly in relation to water-holding capacity and drainage, while from the chemical aspect their influence is illustrated by such examples as digitalis, which cannot tolerate lime, and belladonna, which develops a higher proportion of alkaloid when given nitrogenous manures.

The question of planting material has not yet been mentioned. That the recognition of high and low-yielding strains is every bit as important as in the cultivation of food crops is shown by the successful selection and breeding work carried out by agricultural departments and institutions. The cinchona industry in Java provides a classic illustration of this, while within the Empire the high-yielding strains of derris root developed in Malaya and the Kenya pyrethrum industry may be quoted as examples. Much remains to be done in this field, but the work is necessarily slow to yield results, and with the added difficulty of chemical evaluation which arises with drug crops there is little that the average grower can hope to achieve. It is, however, essential that he should use selected strains whenever such planting material is available.

Harvesting

As might be expected, the content of active substance present in drug plants is not only influenced by the soil and climatic conditions, but also varies at different times in the life of the plant. It is therefore worth considerable trouble to ensure that the crop is harvested at the right time. This variation is governed principally by the stage of development of the plant in relation to flowering, but upon this is superimposed the effect of seasonal changes in weather and of daily variations in light, temperature, etc.

The time of harvesting obviously depends also on the part of the plant which is to be used. Underground reserves in roots, rhizomes, bulbs, etc., are dug up at the end of the vegetative period, prior to flowering the next season. The time of harvesting for such drugs in this country is usually winter or late autumn. Leaves are generally collected just before or during flowering, the time of highest activity varying according to the particular drug. In flowers there are often rapid chemical changes going on as the flower opens, and the presence of the active substance may be only transient, so that harvesting at exactly the right stage is particularly important, e.g. santonica and pyrethrum. Fruits are gathered before they are quite ripe and seed dispersal begins, whilst if it is the seeds themselves that are required, these are most conveniently collected while still in the pod and separated later by sieving.

In certain cases, where the whole herb is taken, the time of collection is dictated rather by seasonal changes in the weather, such as the incidence of the rains or dry season, or of frost. For example, the alkaloid content of ephedra herb is affected by rainfall and is stated to show a temporary decrease even after a single heavy shower. The herb is therefore gathered at the end of the dry season. It is known also that in some medicinal herbs (e.g. stramonium) the content of active principle shows slight diurnal fluctuations brought about by the influence of light and temperature changes, but these are rarely of sufficient importance to be taken into account.

From the point of view of the subsequent drying aerial parts

(herbs, leaves, flowers, etc.) should not be gathered in wet weather, nor in the early morning when the dew is still on the plants.

Preparation and Drying

Drying must begin as soon as possible after harvesting or the material will be spoilt. In certain cases some preliminary treatment is required, for example, roots must be washed free of earth and are commonly cut into slices to facilitate drying, while with leaves it is usual to remove pieces of stalk, etc. There are also special cases, such as that of Chinese rhubarb, where the preliminary treatment is more elaborate.

Much depends on the drying, for the whole of the work and care bestowed on growing and harvesting the plants may be rendered useless in a few hours if the operation is wrongly carried out. It is, therefore, desirable that the general principles of drying should be properly understood.

Once a drug has been harvested the normal metabolism of the plant tissues is interrupted and the active substances present are no longer stable. Chemical changes brought about by the action of enzymes begin to take place at once and may soon result in a complete loss of medicinal value. It is only in exceptional cases that extracts or tinctures can be made from freshly-harvested material and drying is therefore generally employed as a means of arresting these chemical changes. There are other methods, such as exposure to alcohol vapour, technically known as " stabilisation," but these must be followed by drying and so far they have not been widely adopted. While preserving the active substances present in the drug, drying at the same time serves two other useful purposes : it helps to protect the material against fungal and insect attack and also facilitates any powdering of the drug which may later be necessary.

As indicated in the later section dealing with the individual crops, the most suitable manner of drying varies somewhat with different drugs. It has already been mentioned that the chemical changes occurring after collection are a result of enzyme action—a kind of fermentation. They usually take the form of oxidation or hydrolysis, that is to say they constitute a partial breakdown of the substances concerned. This generally means a loss in activity of the drug, and in such cases drying is best carried out as rapidly as possible and at temperatures above the optimum for enzyme action. Roughly speaking, between 50° and 60° C. is suggested ; above this the useful constituents may become unstable. With certain drugs some degree of breakdown is desirable when the active principle does not exist as such in the plant but is only developed partly or wholly as a result of fermentation during the drying process. Obviously in these cases drying should be carried out at temperatures favouring enzyme action, say between 35° and 45° C. The practical implication of this is that, generally speaking, drugs which lose activity rapidly after collection are best dried by artificial heat, while

in cases where the loss of activity is more gradual, or where some enzyme action is definitely beneficial, air drying may be just as effective.

There are certain other points to which consideration must be given. For example, with thick structures like roots or rhizomes drying should at first be gradual as otherwise a hard outer layer may be formed preventing proper drying of the inner tissues. With herbs, leaves and flowers the market requirements as to colour may make special precautions necessary when drying. Another point is the question of subsequent packing or storage. Drugs if completely dry will take up a certain amount of moisture from the atmosphere, and in the so-called air-dry condition they generally contain approximately 12 per cent. of water. In a few cases, such as with digitalis leaf and powdered hyoscyamus, this is sufficient to bring about deterioration through further enzyme action or attack by moulds, and the material must therefore be packed in airtight containers immediately after drying or stored over quicklime. Otherwise storage in a dry place is usually adequate, and packing may be in sacks, bales, or paper-lined boxes with proper protection against damp. Drugs should never be allowed to become wet.

The actual drying technique is relatively simple. Air drying, where possible, is of course the most economical method. Direct exposure to the sun is rarely practicable, for its effects are usually too drastic and result in shrivelling, distortion and loss of natural colour. Sun drying is therefore used only for certain roots and barks which will stand the treatment, and even with these an initial period of slower shade drying is generally advisable. Material which is being dried in the open must, of course, be taken under cover at night or in the event of rain and for this purpose it is convenient to have it spread out on sheets of cloth or wooden trays which can easily be moved.

Shade drying can be carried out in the open in shady or partially shaded situations, the material being spread on trays or cloths as in sun drying. Drying under cover in open, airy sheds, barns or attics is preferable, however, as protection from rain and dew is then afforded. Good ventilation is an essential requirement for satisfactory drying, and where possible advantage should be taken of prevailing winds to secure a steady current of air through the shed. The material to be dried, if consisting of small objects such as flowers and leaves, is laid out on drying trays, whilst herbs that are dried whole may be hung up on wires. The drying trays are held one above the other, about 6 in. to 1 ft. apart, on simply constructed racks. The trays themselves consist of a wooden framework filled in with slats or with wire netting or some material such as burlap or open canvas tightly stretched across. It is advisable to use only tinned wire or wire-netting as the metal may otherwise be corroded by the plant juices coming into contact with it.

The material to be dried should normally be laid out on the

drying trays or hung up as soon as possible after harvesting ; herbs or leaves should never be left heaped up, even for short periods. Care is necessary in handling to avoid bruising delicate leaves, the petals of flowers, etc., especially during the earlier stages of drying. Leaves must be arranged on the trays so that their edges do not overlap, particular attention to this being necessary with sticky leaves, such as those of hyoscyamus. It is advisable to turn the material frequently so as to ensure even drying. This may be done simply by placing an empty tray upside down over the full one and inverting the two together, thus saving time and handling of the material. Drugs which are less fragile can be stirred up or shaken up by tapping the trays from below.

On the subject of drying by artificial heat there is little fresh to add regarding the actual handling ; the design of shed and method of heating are the main considerations. Before passing to these, however, there are a few practical points on technique that are worth noting, particularly in relation to the arrangement of the drugs in the drying shed. During the earlier stages of drying, herbs or leaves give up a great deal of water so that the air passing over them becomes laden with moisture and has little further drying power. The ventilation current carrying away this humid air will be upwards, owing to the heating system in the shed, and it is therefore best to place freshly harvested material on the upper racks where the air will come into contact with it last of all. As drying progresses the material can be moved down to make room for more coming into the shed. When partially withered, herbs and leaves also take up less room. For similar reasons, if it is found that there is too much material to go into the drying shed, the best course is to give preliminary drying in a shaded position outside and finish the operation in the heat. It must be emphasised again that drugs should never be harvested and brought into the shed with rain or dew on them, and where roots must be washed on harvesting they should be allowed to drain thoroughly afterwards.

The design of the drying shed does not make any rigorous demands, and, provided a few guiding principles are kept in mind, the shed is easily fitted up or adapted from some building already available. Generally speaking, it is desirable to have the shed fairly lofty and not too small, but there will be exceptions to this in special types of small driers or adapted apparatus such as chick incubators. Good ventilation is all-important, for without it the air will become saturated with moisture, and, with the heat, provide ideal conditions for rapid growth of moulds. As the warm air rises outlets should be provided at the top of the shed away from the source of heat, and inlets at a low level, but not so many that the heating of the shed becomes difficult. It is an advantage to have an open shelter immediately outside the shed where any excess of material can receive preliminary air drying.

A slow-burning stove is probably the most convenient source of

heat. If this is placed away from the door of the shed the ventilation system can be adjusted so that the distribution of heat is fairly even. Some parts of the shed will still be hotter than others, but advantage can be taken of this in placing drugs which require rapid drying in the hottest positions. A better distribution of heat can be obtained using a stove and pipes as employed in greenhouses, the drying trays being arranged directly above the pipes. Indeed, with a little adjustment of the ventilation, a greenhouse can easily be adapted for drying herbs. The glass should be well shaded by painting over or with curtains or shutters, as drying is best carried out in darkness. This applies also to the windows of other buildings used for drying sheds.

It is obvious that fluctuations of temperature should be avoided as far as possible, though a steady, gradual rise is sometimes desirable, reaching a maximum when the drying is practically completed. The actual temperatures used will depend on the drugs which are to be dried, but, in any case the maximum temperature should not exceed 65° C. (about 150° F.), while 60° C. (140° F.) is a safer maximum, only to be reached after the material has been dried for some time.

For more detailed study the reader's attention is drawn to Nos. 28, 29 and 30 in the list of references; these have been freely consulted in preparing this section and will be found valuable sources of further information.

Notes on Cultivation and Drying of Individual Drugs

In Part I of this paper[1] the case for Empire cultivation of a number of individual drugs was reviewed. In the following pages an outline is given of the essential requirements for their cultivation and drying. For various reasons some of the drugs discussed in Part I are not included here and for convenience of reference an alphabetical arrangement has been adopted.

Calumba.—*Jateorhiza palmata* (*J. columba*), from which calumba root is obtained, is a climbing plant growing wild in the tropical forests of the lower Zambesi and along the coastal belt to Southern Tanganyika. Unsuccessful attempts have been made to introduce the plant into Ceylon, India and Malaya, but the demand for the drug is small and can well be met by the wild material from East Africa.

The fleshy roots which are produced in clusters are dug up in the dry season, the older parts and any pieces of rhizome being rejected. They are cut into oblique or transverse slices and dried without washing off the adhering soil, and in this form the drug is shipped as "natural calumba," usually packed in 1 cwt. bags.

[1] Bulletin of the Imperial Institute, 1941, **39**, No. 1.

Washing, unless carefully carried out, results in a loss of active principle and importers therefore prefer to wash the material themselves on arrival in this country. This gives "washed calumba," which is the official drug.

References: 28, 31.

Caraway.—Caraway (*Carum carvi*) requires a cool temperate climate and flourishes in Western Europe from France and Holland to Northern Scandinavia. The plant is accommodating in its soil requirements, but is said to give the highest yields on medium light soils that have been thoroughly worked and are rich in organic matter.

As caraway is a biennial plant, it is generally grown in conjunction with some annual crop which can be harvested and give a return at the end of the first year. The choice of the annual crop is limited to low-growing plants such as dwarf peas, mustard or field beans which do not overshadow the young caraway.

Sowing takes place in the early spring in rows about 12 in. to 16 in. apart. It may be carried out either in one operation, with the seeds of the two crops thoroughly mixed beforehand, or else as two separate sowings. Frequent hoeing to keep down all weeds and maintain an open soil is most important, especially during the second year after the covering crop has been cut down. During the winter the soil is drawn up around the plants and a dressing of stable manure given. In cases where the plants have made poor growth this is supplemented by a dressing of nitrate of soda.

The stage at which the plants are harvested is a matter of importance, for if allowed to become too ripe the "seeds" (which are, in fact, the fruits) will fall and be lost during reaping. Naturally, therefore, reaping should take place a little before the seeds are fully ripe, but if left late it is an advantage to cut in the early morning while the dew is still on the plants. The crop is cut either by hand, using a scythe or sickle, or by means of a reaping machine.

After reaping the stems are usually bound in loose sheaves and stacked for a few days to dry before threshing. This may be done either by machinery or by hand in the field laying the stems out on a cloth spread over the ground and beating with flails. The yield of seed is very variable and may reach 20 cwt. per acre on rich soil, though half this amount would be considered a fair average yield. 1½ cwt. bags are commonly used for packing the seed.

References: 32, 33.

Cascara.—In its wild state, *Rhamnus purshiana*, which yields this drug, is a small woodland tree growing on the moist lower slopes of the mountain ranges in western North America, from California to Alaska. Commercial supplies of cascara have in the past come almost entirely from trees growing wild and the methods employed for peeling the bark generally involve killing the whole plant. Unchecked collection has led to a rapid depletion of wild stands in

North America, and cultivation on plantation lines is becoming an urgent necessity.

So far cultivation has been on only a limited scale and information on cultural technique is far from complete. There is scope for further work on methods of pruning, by means of which it should be possible to obtain a crop of bark each year from well-grown branches without sacrificing the whole tree. A technique suggested by the United States Department of Agriculture is described in a later paragraph. It is known also that cascara will grow vigorously as coppice, and in view of the relatively high content of active principle in the thin bark of the twigs, their grinding and utilisation entire may well prove an economic means of production in some cases. Cost of transport will play an important part here on account of the greater bulk involved. Another problem worthy of study arises out of difficulties experienced by growers in Kenya, where introduced trees have in some cases made poor growth from the start and in others have died after a few years apparently healthy growth. Grafting cascara on to stocks of a wild species, *Rhamnus prinoides*, which flourishes in this area, is being tried as a possible remedy, but there is so far no information available on the results of the trials.

The crop is normally grown from seed, although propagation by layering is not difficult. The percentage rate of germination is not high and the process is often very slow, but the seeds remain viable for a long time provided they are not allowed to become too dry. To guard against this the seed should be stored in layers between sand (" stratified ") if not planted at once.

Under American conditions autumn sowing is recommended, as seed sown in the spring tends to remain dormant until the following year. The seed should be covered with about ½ in. of soil or less and brought on in shaded seed beds. By the second spring the young trees should be about 1 ft. high and are ready for planting; this should be done early in the season.

In setting up a plantation the natural woodland habitat of the tree must be borne in mind and suitable shading given. Inter-planting with other tree crops may provide a satisfactory solution and put cultivation on a sounder economic basis. A moist but well-drained soil is needed and deep loams rich in humus give the best growth. In dry sandy soils the plant remains poor and shrubby.

The spacing of the plants must depend very largely on the type of cultivation and pruning to be followed, but as a general guide something like 6 ft. each way is suggested. Planting as close as 2 ft. by 3 ft. has been recommended by some, with the removal of alternate trees after a few years growth.

A method of pruning designed to give trees that will yield a steady annual crop of bark has been suggested by the United States Department of Agriculture [36]. " At the time of transplanting, the trees are cut back to a straight stem about a foot high, from

which all except the four uppermost buds are removed. The branches which afterwards develop from these buds are later deprived of their lower side shoots, thus causing the tree to grow a head of four long, stout branches instead of a single straight trunk. When the trees are large enough to yield a crop of bark, the longest of the four branches is cut off early in the spring, flush with the trunk and a new branch is allowed to grow in its place. This process may be repeated yearly, removing only the largest branch of each tree in any one season."

The bark is peeled off in longitudinal strips with the aid of a sharp knife, cured by careful drying spread out on canvas sheets, and finally broken up into small pieces for ease of packing. Shade drying is said to give the best results, but if drying is carried out in the open care should be taken to avoid exposing the inner surface of the bark to the sun as this causes discolouration. During drying it is important to protect the bark from rain, and peeling should not be done in wet weather as this, too, results in staining and discolouration with a consequent fall in market value. Well-prepared bark should have a good orange or golden yellow colour. It must be kept for at least a year to mature before it can be used, but drug merchants generally prefer to buy the bark as soon as dry and store it themselves. 40 lb. to 60 lb. bags are the most usual form of package for the drug.

References : 34, 35, 36.

Chamomile.—The commercial chamomile used in this country is the so-called Roman chamomile (*Anthemis nobilis*), which is a perennial plant and should not be confused with the annual German chamomile (*Matricaria chamomilla*). The plant requires a temperate climate, growing wild in Western Europe, including parts of Southern England where it is also cultivated to a small extent, principally for distillation of the oil.

Chamomile is said to thrive best on stiff dark loams, but it does not seem to be very exacting in its soil requirements and will grow on both clayey and sandy soils. Deep cultivation and clean weeding are necessary, and in poor soils some manurial treatment should be given.

Propagation by seed is regarded as unsatisfactory as generally some of the plants produce single flowers which are of little market value. Vegetative propagation by means of sets is therefore used; the side branches root readily and a well-grown plant of a year old will give up to about a dozen sets. These should be taken from selected plants and are generally planted out in groups of two or three spaced about 18 in. apart in rows $1\frac{1}{2}$ to $2\frac{1}{2}$ ft. apart. In Europe the planting takes place as a rule in early spring; with later plantings the flowering is said to be less prolific.

The flower heads should be harvested just as they open fully, and to obtain the material at the correct stage of maturity frequent

pickings are necessary. In England flowering takes place from September onwards but under East African conditions it is possible that flowering would be more or less continuous all the year round as is often the case with pyrethrum. Care should be taken to ensure that the flowers are not picked when wet with dew or rain as they are then liable to turn black. Yields are very variable, but about 500 lb. of dried flowers per acre may be taken as a good average value.

The commercial valuation of chamomile flowers is based very largely on their whiteness, and to obtain a produce of good appearance rapid and careful drying is required. This should be carried out in a heated drying shed, or, if conditions are favourable, in the sun, with the flowers spread out in thin layers on racks or trays. In order to ensure even drying the flowers must be turned from time to time, especially when sun dried. Finally, the flowers are graded according to size and colour, and packed in paper-lined plywood boxes.

References: 36, 37, 38.

Colchicum.—As in the case of many drug plants, the quantities of colchicum required are strictly limited and under normal conditions can easily be met by collection from plants growing wild in Central Europe. Under such conditions it seems doubtful whether cultivation would be advisable except on a small scale.

Colchicum autumnale, from which the drug is derived, is frequently found in gardens as an ornamental and as no particular attention is needed to grow the plant, it might be introduced into suitable new areas and allowed to establish itself semi-wild. The plant requires a cool temperate climate, its natural habitat being on heavy damp soils usually in woodland clearings but sometimes out in the open.

Propagation is best done by means of the corms, which under European conditions should be planted in August or September, 2 in. to 3 in. deep. The plants may also be grown from seed, but the corms will not then be large enough for harvesting until about five to seven years old. The seeds should be sown soon after ripening in June or July; germination is often slow and the seedlings may not appear before the following spring. Flowering begins when three to five years old.

The corms are best dug up in July, before flowering commences, as it is at this time that they contain most colchicine. In practice, however, it is difficult to locate them after the foliage has died down in the spring and collection, which is laborious work, takes place as soon as the flowers appear in August or September. The drug is usually dried, but can be used fresh—both forms are official. Drying should be carried out as soon as possible after harvesting or the corms will begin to sprout. After removal of the outer scales they are cut into thin slices and spread out on trays to dry in moderate heat. The temperature must not exceed 65° C. or the colchicine which is the active principle of the drug will be destroyed.

The seeds are collected when the mature fruit appears above the ground in June. The whole capsule is gathered and the seeds taken out for drying. As in the case of the corms the temperature during drying must not exceed 65° C.

References : 28, 37.

Digitalis.—The foxglove, *Digitalis purpurea*, which is the source of the official drug, is essentially a plant belonging to cool temperate climates and outside its natural home of Europe it has become naturalised in New Zealand and parts of the Himalayas. The plant grows wild either in open situations or under the light, partial shade of woodland clearings, but does not favour damp situations or extremes of drought. It is intolerant of calcareous soils, even small amounts of chalk leading to stunted growth and a greatly diminished content of glycosides. Care is therefore necessary in choosing a site for cultivation where the soil is free from chalk or limestone, other soil requirements being good drainage and an open texture.

Only seed of selected strains should be used in cultivation as the medicinal activity of different plants is apt to vary widely. Sowing is complicated by the fact that the seeds are extremely small, and it is usual to mix them with fine sand so as to obtain an even distribution in the nurseries. The seedlings should be thinned out to about 4 in. or 5 in. apart in the rows, and the thinnings can readily be transplanted in damp weather to further nursery beds. Sowing takes place generally in the spring and planting out in the field either in the following autumn or else the spring of the next year. The land should be well prepared and manured beforehand, and regular cultivation is required while the crop is growing. The planting distances must be determined by local conditions and the method of cultivation adopted ; something of the order of 2 ft. by 1 ft. is suggested.

The foxglove is normally a biennial, forming a rosette of leaves the first year and flowering in the second, after which the plant dies. In favourable conditions the rootstock will sometimes survive after flowering and the plants may persist for another year or two, but under cultivation the crop is rarely left in after the second year. The leaves, which should be fully mature before harvesting, may be collected either in the first year or from the flowering plants. It is important that they should be dried rapidly and with the minimum possible delay. Artificial drying at a temperature of 55° to 60° C. is almost essential for good results, and the drug should if possible be packed in air-tight containers to prevent it taking up moisture from the air. The yield is of the order of 500 to 600 lb. of dried leaves per acre.

References : 28, 36, 37.

Ephedra.—Ephedra herb is another of the drugs derived solely from wild material, and apart from the small-scale trials with *Ephedra sinica* carried out in the United States very little information is available on the plant's cultural requirements. With the growing competition from synthetic ephedrine it is hardly the time to embark on cultivation in new areas, but rather to make the best use of existing supplies of wild material. If this can be done in India it should be possible to meet all the Empire's requirements with Himalayan material.

Collection of the herb presents many difficulties, for the content of alkaloid is liable to vary greatly under the influence of seasonal changes and local climatic conditions. Correct identification of the species is the first requirement, and for this purpose the paper on Indian Ephedras by Krishna and Ghose [10] will be found most valuable, as well as for the other information which it contains. *Ephedra nebrodensis* and *E. gerardiana* are the species to be collected as it is known that they may have a content of ephedrine well above the 1 per cent. which characterises the average Chinese material. The close similarity of the different Ephedras makes the inclusion of material of inactive species difficult to detect, and adulteration of this type can easily be practised, unless some system of control is established.

In China the herb is gathered in the autumn when the alkaloid content is said to be at its highest. Indian work supports this and indicates that collection in the Himalayas should be made in October and November. The main climatic factor affecting the content of ephedrine appears to be rainfall, and it is reported that even after a single shower of rain the amount of alkaloid present in the herbs is much reduced.

The material should be dried as soon as possible after collection, and is packed in bales for export, the size varying according to the geographical source.

References: 10, 11.

Filix-mas.—This is a drug collected only from the wild plants (*Aspidium filix-mas*), and any attempt at cultivation is out of the question as an economic proposition. Male fern has a fairly wide geographical distribution, however, and it may be possible to extend the range of collection.

The plants are dug up in late autumn, and the fronds cut off just above the base, leaving about an inch of petiole attached to the rhizome. After removal of the roots and scales the rhizomes are cleaned, but not washed, and then dried carefully in the shade. With large specimens drying is assisted by first splitting the rhizome longitudinally.

The drug should not be stored more than one year before use.

References: 28, 29.

Glycyrrhiza.—The liquorice plant (*Glycyrrhiza glabra* and *G. glandulifera*) is a native of the dry, sunny climates of Asia Minor and the Mediterranean, but at the same time requires deep, moist soils. It is usually found growing in swampy areas or alongside streams and rivers, and much of the commercial material is derived from these wild plants. The soil requirements rather limit the areas suitable for cultivation of the crop, as, generally speaking, irrigation would hardly be justifiable on economic grounds and soils of sufficient depth to permit good straight root formation are uncommon.

Glycyrrhiza is a large, bushy herbaceous plant taking from three to five years under cultivation before it is ready for harvesting. It is therefore desirable to grow catch crops between the rows during the first two or three years.

Propagation is by means of the runners, which are cut into short lengths, each piece having two or three buds. The old crowns may sometimes be divided also and used as planting material. Planting takes place commonly in the early spring, and where possible the land should be well manured and prepared beforehand. In this country the sets are usually planted in groups spaced about 1 ft. apart along ridges separated by 2 ft. Weeds should be kept down during the growing period and before each winter the shoots are cut back close to the ground.

The lifting, which takes place in the autumn as soon as the rains have commenced, is a laborious operation as it is necessary to dig a trench beside the plant and loosen the earth between the roots before they can be pulled out. The long, straight roots, after trimming off the small branches, which are rejected, are washed and cut into lengths, then dried slowly under cover for some months. With a proportion of the crop the dark outer cork layer is peeled off before drying, giving " peeled liquorice " which is yellow in colour. The drug is shipped in large bales, which should be protected from the damp.

References : 28, 37.

Hyoscyamus muticus.—Commercial supplies of Egyptian henbane are derived largely from wild plants, and there is little information on cultural requirements. The plant grows as a common weed in the hot desert climate and sandy soils of Egypt, the Sudan, and parts of India, and attempts to grow it under more temperate conditions in Europe have failed. It is said that in fertile situations, such as the Nile valley, the plant behaves as an annual, growing very luxuriantly, while in the desert it may live for three or four years as a rather stunted, small-leaved plant, producing numerous flowers.

The leaves can be dried in the open under shade without difficulty in the climatic conditions obtaining where these plants grow wild.

Reference : 39.

Ipecacuanha.—Ipecacuanha is derived from a low shrubby plant, *Cephaëlis ipecacuanha*, a native of the tropical rain forests of Brazil. Its cultivation is difficult, and outside Brazil it has been established on a commercial scale only in Malaya and to a small extent in Bengal and parts of Burma.

Conditions akin to those of the plant's native habitat are essential in attempting to grow ipecacuanha—a hot climate with high rainfall well distributed over the year and high atmospheric humidity, a deep, well-drained soil, rich in humus, and a shady, sheltered situation. Artificial shade is sometimes recommended as giving better results than natural shade, when the plants are liable to injury by the drip from the leaves of overhanging trees.

Propagation is by cuttings from the stem or fragments of root set about a foot apart each way, preferably in raised beds which will afford better drainage. The crop takes about three years to mature, and it is generally considered inadvisable to use the same land again at once for ipecacuanha. Propagation by seeds is possible, but the seedlings make very slow growth and cannot be planted out until a year old, after which they still require three years to reach maturity.

In Brazil harvesting takes place at almost any time of year. The plants are dug up carefully and the roots should be washed to remove adhering soil and dried in the shade. Not more than 5 per cent. of stem is allowed by the British Pharmacopoeia in official material. The yield is said to average about 2 oz. to 3 oz. of dried root from each plant; the material is generally shipped in bales of about 1 cwt.

References: 28, 40.

Lobelia.—*Lobelia inflata* grows wild in open woodlands and meadows, requiring a moist, temperate climate and loamy soils, rich in humus. The plant, which is an annual, is readily cultivated but must have specially well-prepared ground as the seeds are very small. In the United States sowing is either in autumn or spring, the former giving the better crop as a rule. The seeds are sown in rows about 2 ft. apart, on the surface of the soil, which is best pressed down afterwards to make it firm. Cultivation to keep down weed growth is recommended.

The flowering stems are cut with the upper leaves when the plants are in full flower or when the oldest seed pods are nearly full grown. Careful shade drying is needed to preserve the natural colour and give a good product. Yields are not likely to exceed 1,000 lb. of dried herb per acre, which is considered high. The usual form of packing is in bales weighing either about 1½ cwt. or 3 cwt.

Reference: 36.

Psyllium.—The various species of Plantago (*P. psyllium, P. arenaria* and *P. ovata*) yielding commercial psyllium seed are much alike in their cultural requirements.

Given suitable climatic and soil conditions cultivation presents no difficulties, indeed the plants are often prolific weeds in their native habitat. Generally speaking, they thrive best in a dry, sunny climate of the Mediterranean type, but this is not essential. Both *P. arenaria* and *P. psyllium* are naturalised in the Channel Islands and have been grown successfully in England. Dry sandy soils are the most suitable.

All the species concerned are annuals. The seed is sown in spring in rows about 2 ft. apart and just covered with soil. Little further attention is needed beyond cultivation and weeding between the rows, perhaps once or twice, and the crop is ready for harvesting generally by August. The plants are harvested entire, dried and threshed to free the seed, which is separated by sieving. To improve their appearance the seeds are sometimes polished by shaking them together in a sack.

Reference: 41.

Chinese Rhubarb.—The rhubarb which is official in the British Pharmacopoeia comes from both wild and cultivated plants growing at altitudes of 7,500 ft. to 12,500 ft. in western China and Tibet. The climate in these areas is dry and sunny and it is hardly surprising that the English drug, grown under such different conditions, is not of the same activity. Both climate and soil exert a great influence on the quality of the root produced and it appears that poor soil conditions, resulting in very slow growth, give the most valued product. Most of the best medicinal rhubarb is obtained from wild plants of *Rheum palmatum* var. *tanguticum*, and it is said to be six to seven years before the roots are ready for harvesting. *R. officinale* yields roots of lower quality. Both species are cultivated, but the drug so obtained is regarded as inferior to that from the wild plants.

Information on the Chinese methods of cultivation is rather scanty, but the plant has also been grown in the central regions of the U.S.S.R., and the following notes on the cultural technique adopted there may be of some interest. The soils are mostly of a clayey nature, and it is apparently the practice to give a fair application of manure; under these conditions it is four years before the rhubarb is ready for harvesting. The plants are raised from seed and set out 6 in. apart in nursery beds when large enough. Planting out in the fields takes place about a year after sowing, the spacing being approximately 4 ft. each way. When planting it is usual to remove the leaves and cut back the roots somewhat. Care must be taken not to set the plants too deep, as it is said that they are liable to rotting if the crowns are covered. Flowering

may take place from the second year, but the flower-stalks should be cut off unless the seed is required. Propagation by sets is practiced in English cultivation. These are taken when the crowns are lifted in the autumn and may be planted out any time during the winter.

In China rhubarb is commonly harvested in early summer, before the flowering season, though it may be left until the seeds are nearly ripe, in September. The plants are dug up and after removal of the side-roots the rhizomes are washed and peeled before drying, the larger pieces being sliced longitudinally.

The drying process has an important influence on the activity of the drug, and material dried in the open realises a higher market price than the so-called "high dried" rhubarb, which is dried under cover. The method of open-air drying is to cut up the rhizomes into pieces about 4 in. to 5 in. long, bore them through the middle and thread them on pieces of twine by which they are hung from trees in the shade. Here again the dry, sunny climate plays a significant part, though drying in artificial heat may also be satisfactory. In experiments carried out in this country roots were dried at about 35° C. after previous exposure in the open for some days, the whole drying taking several weeks. A similar technique is followed with the Russian material.

Before shipment the pieces are usually sorted according to shape, the "rounds" or unsliced pieces of small rhizome being separated from the "flats," which are the sliced portions of stouter rhizomes. The drug is generally packed in bags or cases, preferably the latter.

References: 28, 37.

Santonica.—Commercial santonica (obtained principally from *Artemisia cina* and *A. brevifolia*) has so far come entirely from plants growing wild, and it seems doubtful whether cultivation of the drug could be an economic proposition. Nevertheless it might prove worth while introducing these species into new areas where the soil and climatic conditions appear suitable for their growth, particularly as few other plants can flourish under such conditions. The plants are perennials and can be grown from seed.

The area of Central Asia, where commercial santonin is collected, is of the semi-desert type with extremes of temperature, both high and low. The plants seem to favour the saline, sandy soils of this region and form a dominant feature of the vegetation over large areas.

It is important that the flower-heads should be harvested at the correct stage, as the content of santonin is at its highest only for a short time immediately before flowering and falls off rapidly when the heads open. Collection should therefore take place as far as possible just before the buds unfold. The flowering period is so

short that harvesting at the ideal stage is often impracticable, and consequently the santonin-content of bulk material is lower than that of specially picked samples. Under the climatic conditions prevalent where santonin-bearing artemisias grow the drying takes place rapidly and presents little difficulty; the material is then ready for the market.

Santonica from Russian Turkestan, which normally forms the bulk of commercial supplies, usually contains between 2 and 3 per cent. of santonin, while the material from Kashmir has a rather lower content, but is still valuable as a source of santonin. Extraction is scarcely worth while for material with a santonin content much below 1·5 per cent.

Reference: 42.

Squill.—White squill (*Urginea scilla*) is a native of the Mediterranean region, growing chiefly on light sandy soils near the coast. Introduction of the plant into new areas is not advisable as Mediterranean countries can easily meet normal requirements.

Cultivation in the ordinary sense is not generally practiced, but sometimes plantations may be established where the squills, once planted, are allowed to grow without further attention until ready for collection. Occasionally some protection against winter frosts is given. The plantations can be established either from seed or bulbs set in rows about 18 in. apart. When grown from seed it is four or five years before the bulbs are ready.

The bulbs are dug up in August when the leaves have died down, and after removal of the dry outer scales they are cut into slices and dried in the sun or in artificial heat. It is usual also to take out the central scales as these are difficult to dry and retain a tendency to vegetate, even after storage.

Thorough drying is necessary and careful storage in closed containers, for the drug is apt to reabsorb moisture from the atmosphere and become liable to attack by moulds. For shipment squills are usually packed in 1 cwt. sacks or in barrels.

Reference: 28.

Valerian.—Valerian is a perennial herb belonging to the cool temperate regions of Europe. The plant is usually found growing in damp, shady places, often beside the banks of streams. Two varieties are met with: *Valeriana officinalis* var. *sambucifolia* and *V. officinalis* var. *mikanii*. The latter, which is distinguished by its leaf with more numerous leaflets (6 to 10 pairs), usually without serrations, is the variety preferred by growers, as it gives a larger root and at the same time is richer in active substance.

Bearing in mind the plant's natural habitat it is well to choose a moist, rich soil for cultivation, though shade is not essential.

The crop can be grown from seed, but propagation is normally by sets, which are the short side-branches taken from older rhizomes. These are planted out in early spring, generally about 9 in. to 1 ft. apart in rows set about 18 in. apart. Rather closer spacing is adopted when the plants have been raised from seed. During the growing season the beds should be kept free from weeds, and it is usual to cut off all flower stalks as they form. A ridge of soil drawn up round the base of the plants is said to promote formation of a larger rhizome.

Harvesting takes place in late summer or autumn (in the second year if grown from seed). The tops are cut off close to the ground and the rhizomes dug up and washed by leaving for several days in baskets in running water. Drying must be thorough and should be as rapid as possible. Artificial heat is therefore necessary and in this country the drug is dried in kilns, the larger rhizomes being sliced beforehand. Sometimes the rhizomes are dipped in boiling water before drying in order to destroy an enzyme which is associated with the development during the drying process of a brown colour and a very disagreeable odour. The yield may be up to 2,000 lb. of dried root per acre under favourable conditions.

Before the war valerian imported from the Continent was commonly packed in 1 cwt. bags.

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NOTES

Medicinal Herbs in War Time.—The Minister of Health recently appointed an expert Committee (see p. 128) "to review the present and future requirements of vegetable drugs in the light of Empire consumption and trade, and facilities for cultivation within the Empire; to consider the steps which should be taken to secure organisation of cultivation and collection; and to make recommendations to the Minister." The Committee has now issued the following interim report and recommendations.

The report differentiates between two groups of drugs—a "long-term" group and a "short-term" group.

Long-term Group.—It is unlikely that any long-term policy will materially affect the supply of these drugs during the present emergency, as the latent period between initiation of schemes and production for the market is so long. One of the primary essentials for a long-term policy is an assured and steady market and remunerative prices for the producers within the Empire, particularly in respect of drugs requiring many years of experimental cultivation and considerable financial outlay before regular supplies can be available. The establishment of such stable conditions would probably necessitate (*a*) the provision of financial assistance to growers in the Colonies and Dominions over a period of years, and (*b*) protective tariffs against supplies from pre-war producing countries. The present difficult economic and political conditions and the impossibility of knowing or forecasting the economic circumstances and political considerations that may operate at the end of the War make it impracticable and inadvisable at the moment to formulate any proposals involving such questions. The Committee strongly recommends that the position should be further considered as soon as possible after the termination of the war.

Short-term Group.—Here the position is quite different. Supplies can be rapidly created and producers can recoup themselves adequately during the war. After the war stocks may come on the market from countries now cut off from international trade, which may create serious difficulties for growers in the United Kingdom who may have considerable stocks on hand at the cessation of hostilities. Therefore so far as production in the United Kingdom is concerned it is suggested that H.M. Government might appropriately consider the possibility of safeguarding the position of persons who have undertaken the cultivation of drugs in the same way as is being provided for other forms of agriculture.

It is hazardous to grow these plants in climates or soils whose suitability has not been clearly tested by experience and it is preferable to expand production in areas where the plants are already grown and collected. Much could be achieved during the war by

intensifying the collections of wild plants and developing the use of related species or substitutes.

Production in the United Kingdom.—The Committee considers that attention should be concentrated on the following drugs:

Agar.	Ergot.	Psyllium.
Dill.	Filix-mas (Male Fern).	Sphagnum Moss.
Belladonna (leaf and root).	Liquorice Root.	Stramonium.
Chondrus (Irish Moss).	Hyoscyamus.	Taraxacum (Dandelion Root).
Colchicum.	Peppermint.	Valerian.
Digitalis.		

Arrangements have been made by the Ministry of Health for regular growers in the United Kingdom to extend the areas under cultivation of certain extremely important drugs which, with other steps taken to secure supplies, insures that the war-time requirements of these are safeguarded.

The Committee would point out that whilst the development of organised collection of herbs growing wild is most valuable and should be encouraged, the *growing* of medicinal herbs is a highly specialised industry which is not without its dangers to the inexperienced and that therefore growing by amateurs is to be discouraged.

Considerable experimental work is being done at research institutes and agricultural stations on strains, seed production, growing and utilisation of various drugs, the results of which may be important.

Steps have already been taken to encourage methodical collection, proper drying (which is most important) and marketing of drugs growing wild in the United Kingdom.

During 1940 the Ministry of Health was engaged in considerable correspondence with amateur growers and collectors, regarding cultivation, collection and marketing of vegetable drugs, and held several conferences with trade representatives on the subject. The Department also sponsored, in co-operation with the Ministry of Agriculture and Fisheries and the Board of Education, a press notice regarding cultivation of a limited number of vegetable drugs. The outcome of this correspondence and the various conferences was an arrangement whereby private growers and collectors disposed of their crops through regular trade channels.

The stimulation of interest in the supply of vegetable drugs in the United Kingdom has been carried further by the Royal Botanic Gardens, Kew, working in co-operation with the National Federation of Women's Institutes, Boy Scouts and Girl Guides organisations and the Trade.

The Boy Scouts Association has issued a pamphlet ("Collection of Drug Plants by Boy Scouts") giving details of identification, methods of collecting, drying and despatch in respect of the common stinging nettle, dandelion roots, colchicum and foxglove and have arranged that the trade will purchase the collections so made.

The Royal Botanic Gardens, Kew, have arranged with the National Federation of Women's Institutes to organise the collection of ten essential or important herbs in each county, a total of thirty herbs throughout the country. The selection of the herbs is being determined by their abundance in the different counties. Arrangements are being made for two lectures to be given by members of the Pharmacy Colleges and others at the National Federation of Women's Institutes centres in each county to assist members to identify the herbs, and to instruct them in the necessary measures for drying and packing. The Agricultural Organiser of the National Federation of Women's Institutes is issuing periodic circulars of instructions, and articles will be published in the *Journal of Botany* at the collecting season.

Arrangements were made during 1940 by the Department of Health for Scotland and the British Red Cross for organised collection of sphagnum moss and it is hoped now to collect increasing quantities not only in Scotland but also in other parts of the United Kingdom.

The sponsors of these schemes are hopeful that the arrangements made will avoid the disappointments experienced in the last war when so much of the amateur effort was wasted owing to incorrect methods of collection and inadequate preparation for the market; and that they will add substantially to the quantities of essential vegetable drugs available within the United Kingdom.

Miss Barbara Keen and Miss Jean Armstrong have written an illustrated booklet entitled "Herb Gathering," which is available from the publishers, Messrs. Brome & Schimmer, 4 Leather Market, S.E.1, at cost of 9*d*. Attention is also drawn to *Bulletin No.* 121 *of Ministry of Agriculture and Fisheries*, "Medicinal Herbs and their Cultivation," published by H.M. Stationery Office at 6*d*.

The Committee strongly recommends individuals or bodies who may desire to help with collection of drugs growing wild in the United Kingdom to secure the publications mentioned above and to get into touch with the organisers of these schemes.

Production in the British Empire.—The Committee notes with satisfaction that during the past twelve months the Ministry of Health has received many inquiries, offers of help and details of experimental work being carried out from Canada, Australia, New Zealand, East Africa, India and elsewhere. Some of this experimental work has already indicated possibilities of important alternative sources of supply for some drugs normally obtained from outside the Empire.

Consideration was given to the production in respect of argol, agar, wood creosote, datura leaf, ephedra, liquorice root, santonin and squill, and arrangements have been made for various inquiries to be undertaken by the Imperial Institute, the Dominions, Colonial and India Offices.

Attention is drawn to the comprehensive and valuable memorandum prepared by M. Ashby, Ph.D., D.I.C., A.R.C.S., on

" War-Time Drug Supplies and Empire Production," published in the BULLETIN OF THE IMPERIAL INSTITUTE, Vol. 39 (1941), No. 1, which is cordially commended to the attention of the agricultural departments of the Dominions, Colonial and India Offices.[1]

A Sub-Committee has been set up to act as a clearing centre for information and advice. This committee will deal with all inquiries, promote experimental work and initiate action where necessary.

Membership of " Vegetable Drugs " Committee

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Market for Empire Feathers and Down.—Inquiries have recently been received at the Imperial Institute regarding the possibility of obtaining goose and duck feathers and down, and also chicken feathers, from the British Empire. In normal times supplies of these products are obtained mainly from the United States of America, Eire, China and Continental countries, in particular Denmark, France and Hungary, imports ranging from 5,000 to 7,000 tons per annum. Annual consumption of feathers and downs of all kinds in Great Britain is estimated at about 8,500 tons in an active year's business. Imports of feathers for beds, etc., into the United Kingdom for the years 1935-1939 are shown in the following table :

[1] The second part of Dr. Ashby's paper appears in this issue (pp. 106-124).

IMPORTS OF FEATHERS FOR BEDS, ETC., INTO THE UNITED KINGDOM

From.	Quantities.					Value.				
	1935.	1936.	1937.	1938.	1939.	1935.	1936.	1937.	1938.	1939.
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	£.	£.	£.	£.	£.
Eire	11,625	8,348	10,659	10,006	14,082	39,945	29,455	40,947	30,615	38,629
Hong Kong	5,847	13,844	18,162	8,804	6,214	26,243	55,560	112,517	38,035	26,006
Other British Countries	30	106	1,022	821	714	32	105	1,415	715	770
Total from British Countries	17,502	22,298	29,843	19,631	21,010	66,220	85,120	154,879	69,365	65,405
Denmark (including Faröe Islands)	30,980	33,836	24,623	26,004	24,833	112,526	121,240	117,650	96,715	82,978
Poland (including Dantzig)	2,002	1,896	2,250	836	328	9,105	10,540	15,505	7,575	6,157
Germany	1,918	1,453	1,583	69	374	12,442	7,901	10,240	1,027	2,143
France	3,202	7,940	19,582	14,849	30,802	9,500	19,948	51,187	39,179	67,620
Hungary	102	1,042	2,949	2,329	2,255	1,838	3,849	20,568	13,366	16,118
China (exclusive of Hong Kong, Mação, Manchuria and leased territories)	32,350	10,358	19,329	4,511	8,004	169,574	45,000	120,916	22,681	37,087
United States of America	23,380	34,589	45,012	23,239	31,542	20,948	33,898	69,537	28,563	46,336
Other Foreign Countries	6,385	5,450	9,878	1,825	3,620	16,035	22,018	36,139	11,049	17,159
Total from Foreign Countries	100,319	96,564	125,206	73,662	101,758	351,968	264,394	441,742	220,155	275,598
Total	117,821	118,862	155,049	93,293	122,768	418,188	349,514	596,621	289,520	341,003

It is possible that potential supplies of feathers and down are available in other Empire countries apart from Eire, and the Imperial Institute would be glad to hear from possible suppliers in the British Empire and to submit any samples received to firms in order to obtain a report as to their suitability for the market in this country. At the same time it would be useful to have some idea of the quantities likely to be available and the prices at which they could be offered.

It should be pointed out that imports of feathers and down into the United Kingdom are controlled by the Plumage Act, under which such imports are restricted to "feathers of birds ordinarily used in the United Kingdom as articles of diet."

With regard to the preparation of the feathers for export, the following notes may be of interest.

In China feathers are collected from the farmers by men who pay regular visits to country districts and buy up the stocks available. These stocks are then disposed of to wholesale buyers, who in turn sell them to the collecting agencies of the chief exporting firms.

On reaching the agencies the feathers are hung in a well-ventilated place to dry before being sorted by women into different grades. The graded feathers are then placed in a bag and plunged into a solution of washing soda to get rid of impurities. They are allowed to soak in the solution for about two days and are then disinfected by boiling. After boiling they are taken out of the bag and thoroughly washed in clean water before being dried in the sun and packed for export. Packing is usually in bales, with dirt guaranteed not to exceed from 10 per cent. to 25 per cent. according to quality.

Any feathers with a fishy or other odour should be eliminated since they are unsaleable, and as regards duck and goose feathers, the wing, tail and big and small spiky feathers should also be removed. Body feathers from chickens should be stripped before marketing, and the stripping is best done by holding the feather at its extreme tip and tearing off both sides. Down, duck, goose and chicken feathers should, of course, be sorted separately, and tail, body and wing feathers should not be mixed. White feathers fetch a higher price than coloured ones and should be kept separately. On arrival in this country feathers and down are sent to firms of purifiers for the removal of dust, dirt, etc.

In the United States of America the commercial supplies of feathers are obtained chiefly from poultry packing plants, where mechanical devices are employed for plucking them, either by dry plucking, scalding, or waxing. Since the feathers are a by-product of the industry, the method by which the birds are plucked depends entirely on the way in which they are prepared for the market. After plucking the feathers are stored in well-ventilated rooms and are stirred daily until they are thoroughly dry. It is important that feathers should be completely dried before shipment, since they are liable to mat together if packed wet. To save time drying machines

are commonly employed, and where the feathers are dry-plucked they are collected from the floor or from boxes by means of suction pipes. It is estimated that the feathers constitute about 7 per cent. of the live weight of the bird.

It should be stressed that if feathers from Empire sources are to find an outlet here they will have to compete in quality and price with those normally marketed here from foreign countries, and a well-prepared product is, therefore, essential.

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The Baikiaea Forests of Northern Rhodesia. By J. D. Martin. *Emp. For. J.*, 1940, **19**, 8-18. An account of the occurrence, silviculture and exploitation in Northern Rhodesia of *Baikiaea plurijuga*, the principal commercial sleeper timber of South Africa.

Budongo—An East African Mahogany Forest. By W. J. Eggeling. *Emp. For. J.*, 1940, **19**, 179-196.

The Growing of *Populus deltoides* in South Africa. By E. L. Schiemer. *J. S. Afr. For. Assoc.*, 1940, No. 5, 17-28.

Foliage Insects of Spruce in Canada. By A. W. A. Brown. *Publ. No.* 712, *Dep. Agric. Canada.* Pp. 29, 9¾ × 6½. (Ottawa: Department of Agriculture, 1941.)

Life History and Control of the Imported Willow Leaf Beetle (*Plagiodera versicolora*). By C. E. Hood. *Circ. No.* 572, *U.S. Dep. Agric.* Pp. 9, 9 × 6. (Washington, D.C.: Superintendent of Documents, 1940.) Price 5 cents.

Charcoal Kilns in the Matang Mangrove Forests. By E. D. Robertson. *Malay. For.*, 1940, **9**, 178-183. An account of charcoal production in this district.

The Examination of Some Australian Hardwood Charcoals with Special Reference to Their Suitability for Charcoal Gas Producers. By J. N. Almond, B. M. Holmes and E. C. Plante. *Pamphl. No.* 103, *Coun. Sci. Industr. Res. Aust.* Pp. 28, 9½ × 6. (Melbourne: Government Printer, 1940.)

Timber

Australian Standard Nomenclature of Australian Timbers. *Tech. Stand. No. O.*2—1940, *Stand. Assoc. Aust.* Pp. 84, 9 × 6. (Sydney: Standards Association of Australia, 1940.) Price 7*s.* 6*d.*

Malayan Timbers Tested in a Green Condition. By A. V. Thomas. *Malay. For.*, 1940, **9**, 151-157.

Tests on Small Clear Specimens of Merawan meranti (*Hopea sulcata* Sym.) in a Green Condition made at the Timber Research Laboratory, Sentul. *Malay. Forester*, 1941, **10**, 29-34.

The Teak Industry of Burma. By J. R. Gardiner. *Timber and Plywood, Annual Special Issue*, 1940, 18-30.

Yield and Stand Tables for Teak (*Tectona grandis* Linn. f.) Plantations in India and Burma. By M. V. Laurie and Bakhshi Sant Ram. *Indian For. Rec.* (*New Series*) *Silvic.*, 1940, IVA, No. 1. Pp. 115, 8½ × 5½. (Delhi: Manager of Publications, 1940.) Price Rs. 4 As. 6.

American Hardwood Plywood. By J. L. Muller. *Tr. Prom. Series No.* 210, *U.S. Dep. Comm.* Pp. 65, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1940.) Price 10 cents. An account of the hardwoods employed, methods of manufacture, uses of plywood and the organisation of the industry.

Effect of Blue Stain on Specific Gravity and Strength of Southern Pine. By A. D. Chapman and T. C. Scheffer. *J. Agric. Res.*, 1940, **61**, 125-133.

The Destructive Distillation of Maple Wood. By D. F. Othmer and W. F. Schurig. *Industr. Eng. Chem.*, *Industr. Ed.*, 1941, **33**, 188-196.

Gums and Resins

Annual Report of the Indian Lac Research Institute, India, for the year 1938-39. Pp. 49, 9½ × 7½. (Namkum, Bihar: Indian Lac Research Institute, 1940.)

Annual Report of the Indian Lac Cess Committee for the year April 1, 1939, to March 31, 1940. Pp. 33, 8¾ × 5½. (Ranchi, Bihar: Indian Lac Cess Committee, 1940.)

Tanning Materials

The Growth of Mangrove Species in Malaya. By C. C. L. Durant. *Malay. For.*, 1941, **10**, 3-15.

A Comparison of Wattle Growing in Natal and in Kenya. By S. H. Wimbrush. *E. Afr. Agric. J.*, 1941, **6**, 121-126.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 14

(January to March 1941)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Chemistry in Insect Control. By E. G. Thomsen and M. H. Doner. *Soap*, 1941, **17,** No. 1, 107, 109, 111, 125. Includes a general account of organic insecticides.

War on Insect Pests. By A. E. Cameron. *Scot. J. Agric.*, 1941, **23,** No. 2, 169-178. Includes paragraphs on the use of derris, pyrethrum and nicotine.

Advances in Entomology (Insecticides). By C. H. Richardson. *Industr. Engng. Chem., News Ed.*, 1941, **19,** No. 2, 77-88. Includes section reviewing recent work on insecticides of plant origin.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, pp. 104-106. Insecticidal Plants (Tobacco, Derris, Pyrethrum, etc.) and their Constituents. Notes of work on nicotine (especially nicotine-bentonite), lonchocarpus, derris, tephrosia and certain other plants with reputed insecticidal properties.

Laboratory Testing of Natural and Synthetic Organic Substances as Insecticides. By M. C. Swingle, A. M. Phillips and J. B. Gahan. *J. Econ. Ent.*, 1941, **34,** No. 1, 95.

A List of Commercially Available Detergents, Wetting, Dispersing and Emulsifying Agents. By H. L. Cupples. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine*, E.504, June 1940.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, p. 109. Accessory Materials for Use with Insecticides.

Droplet Size of Insecticides. By E. M. Searls. *Soap*, 1941, **17,** No. 2, 94-96.

Insecticide Stickers. Use of Rosin-mineral Emulsion as a Sticker for Agricultural Insecticides. By R. D. Chisholm. *Soap*, 1941, **17,** No. 1, 113, 125.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, p. 106. Studies of geraniol (from Java citronella oil) as an attractant for Japanese beetle.

Bee Poisoning: a Review of the More Important Literature. By F. R. Shaw. *J. Econ. Ent.*, 1941, **34,** No. 1, 16-20.

The Insecticidal Effects of Organic Compounds. I. Toxicity of Sulphur and Nitrogen Compounds to Fleshfly Larvæ. By W. M. Hoskins, H. P. Bloxham and M. W. Van Ess. *J. Econ. Ent*, 1940, **33,** No. 6, 875-881. Substances tested include nicotine and rotenone.

Combating Fruit Pests in Kansas. By G. A. Filinger. *Circ. No.* 199, *Kansas Agric. Exp. Sta.*, 1940, pp. 18, 19, 20. Brief notes on use of nicotine sulphate sprays. Pyrethrum and derris extracts too expensive for orchard application.

The Present Status of Organic Insecticides for Codling Moth Control. By R. L. Webster, J. Marshall and Herman Fallscheer. *J. Econ. Ent.*, 1940, **33**, No. 6, 909-912. Value of nicotine combinations and pyrethrum extracts discussed. Pyrethrum has in general given discouraging results.

Action of Contact Larvicides on *Lucilia cuprina*. By F. G. Lennox. *Council for Scientific and Industrial Research, Australia, Pamphlet No.* 101, 1940, 69-131. Quantitative study of many contact insecticides, both synthetic and plant products.

Insect Pests of Tomatoes. Control Measures. By R. T. M. Prescott. *J. Dep. Agric. Vict.*, 1940, **38**, Pt. 3, 140-152. (*R.A.E.*, 1941, **29**, A, Pt. 1, 30-32.) Use of nicotine and pyrethrum dusts against various pests.

Studies of Methods and Materials for the Control of the Leafhopper, *Empoasca fabæ* as a Bean Pest. By D. M. De Long. *Tech. Bull. No.* 740, *U.S. Dep. Agric.*, 1940, p. 5. Tests with pyrethrum and nicotine sulphate sprays.

Combined Derris-Nicotine Dusts for Cabbage Insects. By J. W. Brooks and T. C. Allen. *J. Econ. Ent.*, 1940, **33**, No. 2, 416-417. (*R.A.E.*, 1941, **29**, A, Pt. 3, 135.)

Lygus Injury to Peaches in the Pacific North-west and its Prevention. By J. B. Moore and C. C. Fox. *J. Econ. Ent.*, 1941, **34**, No. 1, 99.

Bed Bug Control. *Chem. and Drugg.*, 1941, **134**, January 18, 39 (from *Lancet*, 1941, January 11, 55). Pyrethrum powder effective when used fresh. Also tobacco powder, quassia and hellebore found effective.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Island Leaf a Raw Material Source of the Nicotine Sulphate By-Product. By Miguel A. Manzano. *Tobacco, N.Y.*, 1940, **111**, No. 26, 14. Varieties in Puerto Rico suitable for manufacture of nicotine sulphate.

Determination of Nicotine in Fresh Tobacco Leaf. By L. N. Markwood. *J. Assoc. Off. Agric. Chem.*, 1940, November.

The Effect of Ultraviolet Radiation on Nicotine. By C. H. Rayburn, W. R. Harlan and H. R. Hanmer. *J. Amer. Chem. Soc.*, 1941, **63**, No. 1, 115-116. Toxicity lost in presence of oxygen. Oxynicotine, methylamine and nicotinic acid formed.

Use of Karaya Gum as an Activator for Nicotine Sulphate against *Aphis rumicis*. By P. Garman. *Bull. No.* 428, *Connecticut Agric. Exp. Sta.*, 1939, p. 76.

A Study of Clays used in Preparation of Tank-mix Nicotine-Bentonite Sprays. By J. E. Fahey. *J. Econ. Ent.*, 1941, **34**, No. 1, 106.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, pp. 106-107. Spray Residues and their Removal. Includes note on the removal of nicotine residues.

The Influence of Sodium and Calcium Chlorides on Toxicity of Nicotine to Eggs of *Musca domestica* L. By J. W. Apple. *J. Econ. Ent.*, 1941, **34**, No. 1, 84.

Toxicity of Some Nitrogenous Bases to Eggs of *Lygæus kalmii*. By C. F. Smith. *J. Econ. Ent.*, 1940, **33**, No. 5, 724-727. Toxicity of the materials tested, expressed in descending order was : nicotine and quinoline (equal), anabasine, piperidine, sodium oleate and pyridine. Quinoline alone killed the eggs at once ; the other compounds permitted some development of the embryo.

Combating Fruit Pests in Kansas. By G. A. Filinger. *Circ. No.* 199, *Kansas Agric. Exp. Sta.*, 1940, pp. 18, 19, 20. Brief notes on use of nicotine sulphate sprays. Pyrethrum and derris extracts too expensive for orchard application.

Mealy Bug Infestation of Citrus Trees. By O. E. Halliday. *J. Dep.*

Agric. S. Aust., 1940, **43**, No. 12, 847-851. Recommends spraying with nicotine sulphate and white oil in cases of bad infestation.

Two Years Results with Codling Moth Sprays. By C. L. Burkholder, D. L. Johnson and O. W. Ford. *J. Econ. Ent.*, 1940, **33**, No. 5, 713-717. Nicotine-bentonite oil-mix gave good control, but required more frequent coverage than lead arsenate oil sprays. Costs reduced by combined schedule using nicotine-bentonite oil for first brood period followed by lead arsenate.

Toxicity of Several Nicotine Compounds to *Aphis rumicis* L. By R. Hansberry and L. B. Norton. *J. Econ. Ent.*, 1941, **34**, No. 1, 80.

Sixty-fifth Annual Report of the Ontario Agricultural College and Experimental Farm, 1939 (1940), p. 55. Four per cent. nicotine dust effective against turnip aphid.

Measures for the Control of Chinch Bug infesting Lawns in Trinidad. By A. Pickles. *Trop. Agric., Trin.*, 1940, **17**, No. 12, 236-237. Nicotine-soap preparation effective but expensive; pyrethrum extract or dusts of nicotine or derris used in conjunction with oil emulsions ineffective.

Other Alkaloid-containing Materials

Insecticidal Action of Extracts of *Veratrum viride*. By R. A. Fisher. *J. Econ. Ent.*, 1940, **33**, No. 5, 728. High toxicity to certain insects may make the drug an important insecticide when practical extraction methods are perfected. Standardisation should be based on ether-soluble alkaloids only.

Toxicity of Some Nitrogenous Bases to Eggs of *Lygæus kalmii*. By C. F. Smith. *J. Econ. Ent.*, 1940, **33**, No. 5, 724-727. Anabasine less toxic than nicotine.

Nuages d'alkaloides dans la lutte contre les moustiques. (In Russian.) By E. A. Pogodina and A. G. Sokolov. *Med. Parasit.* (*Moscow*), 1940, **9**, No. 1-2, 109-111. (*R.A.E.*, 1941, **29**, B, Pt. 2, 27.) Use of anabasine mists.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Insecticides and Fungicides. By E. H. Bear. *Fruit-Grower*, 1941, **91**, March 27, 275-276. Brief general account of derris and lonchocarpus.

Raw Material Supplies (U.S.A.). Address by C. C. Concannon at National Association of Insecticide and Disinfectant Manufacturers' Convention (December 1940). *Oil, Paint, Drug Rep.*, 1940, **138**, No. 24, 30 D. Discusses position of rotenone imports.

What of Raw Materials? By C. C. Concannon. *Soap*, 1941, **17**, No. 2, 101-103. Includes brief note on rotenone position.

Effects of Some Ingested Insecticides on the Midgut Wall of the Southern Armyworm Larva. By P. A. Woke. *J. Agric. Res.*, 1940, **61**, No. 5, 321-329. Rotenone tested.

Experiments with Derris and Cube Dusts for Pea Weevil Control. By T. A. Brindley, F. G. Hinman and R. A. Fisher. *J. Econ. Ent.*, 1940, **33**, No. 6, 881-886. Satisfactory control from both derris and cube dusts.

A Progress Report on the Use of Rotenone Dusts for the Control of the Pickleworm and Melonworm in Alabama. By F. S. Arant. *J. Econ. Ent.*, 1940, **33**, No. 6, 840-843.

Derris

The Production and Marketing of Derris Root. By A. F. Sievers. *U.S. Dep. Agric., Bur. Plant Industr.*, 1940. (*R.A.E.*, 1941, **29**, A, Pt. 2, 88, in title only.) A review of the literature.

Indian Derris. *Soap*, 1941, **17**, No. 2, 96 (from *Indian J. Pharm.*, 1940, **1**, 130.) Analysis of roots from South India.

Annual Report on the Departments of Agriculture, Malaya, for the year 1939 (1940), p. 2. Derris exports advanced during 1939, pp. 4-5. Chemical investigations showed toxic content of derris to be a hereditary character; variation in yield and toxic content with age also studied.

Le derris et ses propriétés insecticides. (In Russian.) By V. S. Mironov, V. A. Nabokov and E. K. Kachalova. *Med. Parasit.* (Moscow), 1940, **9**, No. 1-2, 106-108. (*R.A.E.*, 1941, **29**, B, Pt. 2, 26.)

Studies on the Lethal Effects of Insecticides. Pt. I. The General Results of Previous Experiments with Derris upon various Species of Insects (In Japanese.) By T. Moriyama. *Formosan Agric. Rev.*, 1939, **35**, No. 10, 765-775; No. 11, 870-887; 1940, **36**, No. 1, 42-72; No. 2, 136-171. (*R.A.E.*, 1941, **29**, A, Pt. 2, 88, in title only). A review of the literature.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, p. 110. Note of a study of the influence of temperature on the toxicity of rotenone and phenol to goldfish.

Derris Residue on Marketable Cabbage. By C. C. Cassil. *J. Econ. Ent.*, 1941, **34**, No. 1, 77.

Annual Report of the Director of Agriculture, Cyprus, for the year 1939 (1940), p. 3. Experiments showed derris dusts and extracts ineffective against aphid except at concentrations that would prove much more costly than nicotine sulphate soap sprays.

Mededeelingen van het Deli Proefstation te Medan, Sumatra. Series 3, No. 7, 1940 (Report for year 1939), pp. 52-59. Tests with derris powder against lice, certain larvæ and capsids.

Lonchocarpus

Lonchocarpus: Its Uses and Value. By H. I. Kingston. *Fruit-Grower*, 1941, March 13, 236. General account with examples of pests on which lonchocarpus has proved effective.

Others

Changes in Insecticidal Value of Roots of Cultivated Devil's Shoestring, *Tephrosia virginiana*, at four Seasonal Growth Periods. By A. F. Sievers, M. S. Lowman, G. A. Russel and W. N. Sullivan. *Amer. J. Bot.*, 1940, **27**, 284-288. (*Brit. Chem. Abstr.*, 1941, February, B, III, 39.) At the full-bloom stage the toxicity of the root extracts to houseflies, the carbon tetrachloride extract and rotenone content of the roots are at a maximum. Toxicity of the roots of clonal progenies of the same parent plants showed no significant difference, but variations occurred in the roots of progenies of different parents.

Toxicity to the Housefly of the Noncrystalline Constituents of Roots of *Tephrosia virginiana*. By L. D. Goodhue and W. N. Sullivan. *J. Econ. Ent.*, 1941, **34**, No. 1, 77.

Insecticidal and Larvicidal Action of *Tephrosia vogelii*. By R. N. Chopra, D. N. Roy and S. M. Ghosh. *J. Malar. Inst. India*, 1940, **3**, No. 1, 185-189; note in *Soap*, 1941, **17**, No. 2, 115. (*R.A.E.*, 1941, **29**, B, Pt. 1, 10.) Acetone extracts effective on mosquito larvæ.

PYRETHRIN-CONTAINING MATERIALS

Raw Material Supplies (U.S.A.). Address by C. C. Concannon at National Association of Insecticide and Disinfectant Manufacturers' Convention (December 1940). *Oil, Paint, Drug Rep.*, 1940, **138**, No. 24, 30D. Discusses position of pyrethrum shipments to U.S.

What of Raw Materials ? By C. C. Concannon. *Soap*, 1941, **17**, No. 2, 101-103. Includes brief note on position with regard to pyrethrum supplies.

Extraction and Determination of Pyrethrin I in Ground Pyrethrum Flowers. By J. S. Yip. *Industr. Engng. Chem., Anal. Ed.*, 1941, **13**, No. 2, 107-108.

Determination of Pyrethrins. By F. B. La Forge and F. Acree, Jr. *Soap*, 1941, **17**, No. 1, 95-98, 115. A method for the quantitative determination of pyrethrins based on cleavage on hydrogenation.

Stabilisation of Pyrethrum. *Soap*, 1941, **17**, No. 2, 115. Treatment with sulphur dioxide prevents action of oxidase and has the effect of stabilising the content of pyrethrins.

The Effect of Pyrethrum on the Spiracular Mechanism of Insects. By V. B. Wigglesworth. *Proc. Roy. Ent. Soc., Lond.*, 1941, **16**, Pts. 1-3, 11-14.

Pyrethrum Extract. *Soap*, 1941, **17**, No. 2, 113. Brief note of a Japanese patent.

Insecticidal Mixture. *Soap*, 1941, **17**, No. 2, 113. Japanese patent incorporating the seed oil of *Zanthoxylum piperitum* with pyrethrum extracted with acetone.

The Hawaiian Beet Webworm and its Control. By H. G. Walker and L. D. Anderson. *Bull. Virginia Truck Exp. Sta.*, 1940, No. 103, 1651-1659. (*R.A.E.*, 1941, **29**, A, Pt. 2, 46.) Pyrethrum dusts and sprays gave satisfactory results ; derris and other rotenone dusts ineffective. (Paper published in *J. Econ. Ent.* ; see Bibliography No. 12.)

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, p. 105. Chemistry of the active principle of the Amur cork tree (*Phellodendron amurense* Rupr.) is being studied. Preliminary investigations have been made on a number of plants reputed to have insecticidal properties, including thunder-god vine (*Tripterygium wilfordii* Hook. f.), Kentucky coffee-tree (*Gymnocladus dioica* (L.) Koch), sweet basil (*Ocimum basilicum* L.), creosote bush (*Larrea divaricata* Cav.) and *Stillingia dentata* (Torr.) Britt. and Rusby. Only the thunder-god vine gave results sufficiently encouraging to warrant further work.

Insecticidal Properties of Fruit of *Phellodendron* spp. *J. Econ. Ent.*, 1940, **33**, No. 6, 941. Note by H. L. Haller.

Chinese Insecticidal Plant Toxic to Codling Moth Larvæ. *Science*, 1941, 93, January, 60. Stomach poison properties of *Tripterygium wilfordii* Hook. f. (" Thunder-God Vine ").

New Insecticide Material. *Soap*, 1941, **17**, No. 2, 96. Brief note on potential value of " Thunder-God Vine " which is being investigated in the United States.

Report of the Chief of the Bureau of Entomology and Plant Quarantine, U.S.A., 1940, p. 106. Note of further studies of *Helenium* spp., and the investigation of a bitter substance found in them which is analogous to the quassin in quassia wood.

Insecticidal Mixture. *Soap*, 1941, **17**, No. 2, 113. Japanese patent incorporating the seed oil of *Zanthoxylum piperitum* with pyrethrum extract.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

WHALE OIL: AN ECONOMIC ANALYSIS. By Karl Brandt. Fats and Oils Studies of the Food Research Institute, Stanford University, California, No. 7, June, 1940. Pp. xi + 264, 8¾ × 5¾. (California: Food Research Institute, Stanford University; London: P. S. King & Son, Ltd., 1940.) Price $3.00.

Although it is only in recent years, by the introduction of the process of hydrogenation and improvements in the method of refining, that whale oil has come to the forefront as a serious competitor of vegetable oils in the margarine and other industries, the whaling industry has always exerted an important influence in world economics. Many of the earliest industrial fortunes were built up on whale fisheries and three centuries ago the first joint stock companies in England and Holland were engaged in whaling.

The author of the present study deals with the growth of the industry from the earliest days to its present position. In the first part, "Whaling," he gives a good account of the various kinds of whales and related animals, the products they yield (whale oil, whalebone, sperm oil and spermaceti, meat and so on), the rise, decay and revival of whaling, the methods employed in modern whaling, and discusses international competition and co-operation in whaling. The second part, "Whale Oil," covers such aspects of the subject as world supplies, costs and profits, the demand for whale oil, transport, storage and marketing, tariff duties, excise taxes and other protective measures, and the price of whale oil. The author's views on the outlook for whale oil and whaling form Part III. Statistics of the whaling industry, trade in whale oil, and prices are given in appendix tables and there is a full bibliography.

It will be seen that every side of this most important subject is dealt with by the author, and the book is a most valuable addition to the literature of oils and fats.

FRUIT CROPS. Principles and Practices of Orchard and Small Fruit Culture. By T. J. Talbert and A. E. Murneek. Pp. 345, 9¼ × 6. (London: Baillière, Tindall & Cox, 1939.) Price 19s.

Although this book is written essentially for the American reader concerned with fruit growing in the United States, the treatment of the subject is such that there is much in the text that will apply to other temperate countries. The fruits discussed do not include citrus, but cover apples, pears, plums, cherries, peaches and other stone-fruits, grapes, strawberries, cane- and bush-fruits and nuts.

The work is intended primarily as a textbook for college students, and as such it deals more with the general principles and technique of fruit production than with specific problems related to individual crops, although that aspect is not neglected. In the first twelve chapters, which form the greater part of the book, cultivation is considered generally without reference to particular fruits. There is a brief account of selection and breeding followed by more detailed descriptions of propagation methods—budding, grafting and layering. Soil factors are then discussed with reference to planting, irrigation, drainage and manuring. Then follow chapters on pollination and fruit thinning, pruning deciduous fruit trees, insect pests and diseases of fruit crops and their control by spraying and dusting. It is regrettable that in this last chapter the wide application and value of plant insecticides such as derris, pyrethrum and nicotine are scarcely referred to beyond the briefest mention, although some inorganic sprays and dusts are dealt with in comparative detail. The remainder of the book is devoted to accounts of the crops themselves, with final chapters on harvesting, packing and grading and fruit marketing.

The book contains a number of illustrations and each chapter concludes with a list of selected references ; a more detailed index would have added to the value of the work.

CANNING PRACTICE AND CONTROL. By Osman Jones, F.I.C., and T. W. Jones, B.Sc. Second Edition, revised and enlarged. Pp. xiv + 311, $9\frac{3}{4} \times 6\frac{1}{4}$. (London : Chapman & Hall, Ltd., 1941.) Price 32*s*.

This book first appeared less than four years ago (see this BULLETIN, 1937, **35**, 273). The fact that the edition was exhausted in so short a time is a testimony to its utility. Very little in the way of revision of the original matter has been necessary, but considerable additions have been made in order to keep abreast of the rapid progress of the canning industry in this country and the new edition contains nearly 60 pages more than the first. Special attention should be directed to the enlargement of the chapter on canning processes, to the new analytical methods given in the chapters on the examination of raw foodstuffs and of canned foods, and to the account of recent work on thermophile organisms in the chapter on organisms causing food spoilage. There is an entirely new chapter on packing foods in glass containers. New illustrations have also been included.

In its enlarged form this book will continue to be a valuable source of information on the basic principles underlying canning practice. As was mentioned in our notice of the previous edition it does not profess to give details of the different methods employed for processing individual canned products.

INSECT TRANSMISSION OF PLANT DISEASES. By Julian Gilbert Leach, Ph.D. Pp. xviii + 615, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 42s.

The important part that insects play in the transmission of certain plant diseases has become more and more recognised during the past two or three decades and a very large amount of work on the subject has been carried out. Professor Leach, who himself has taken a prominent part in researches in this direction, has performed a most useful service in bringing together the scattered information that has been published. He points out that no attempt has been made to discuss all diseases transmitted by insects or all insects that transmit diseases. Emphasis has been placed on those which have been investigated most completely or which are best suited for illustrating the various principles of insect transmission. The student is directed to fuller particulars by the lengthy list of references at the close of each chapter.

The comprehensive character of this treatise can best be indicated by an enumeration of the chapter headings: The Interrelationship of Plants and Insects; Symbiosis between Insects and Micro-organisms and its Significance in Plant Pathology; The Relation of Insects to the Spread and Development of Plant Disease; Plant Diseases caused by Toxicogenic Insects; Insects and Bacterial Diseases; Insects and Fungus Diseases; Insects and Virus Diseases (the importance of this subject has necessitated two chapters running to over 100 pages); Insects and Phytopathogenic Protozoa; Mites, Nematodes and other Small Animals as Vectors of Plant Diseases; The Anatomy and Physiology of Plants in Relation to Infection and Insect Vectors; The Anatomy and Physiology of Insects in Relation to the Transmission of Plant Diseases; The Inocula of Plant Pathogens in Relation to Insect Transmission; The Feeding and Breeding Habits of Insects in Relation to the Transmission of Plant Diseases; Insect Transmission of Animal Diseases compared with Insect Transmission of Plant Diseases; and Methods Useful in the Study of Insect Transmission of Plant Diseases.

Information as to the various plant diseases and their respective insect vectors is tabulated in an Appendix under the names of the diseases and also under the names of the vectors. Tables are also given comparing certain fungus and virus diseases with respect to significant transmission phenomena and there is a similar table of certain representative diseases of animals.

GENERAL BACTERIOLOGY. By D. B. Swingle. Pp. xii + 313, 9 × 6. (London: Chapman & Hall, Ltd., 1941.) Price 16s.

This textbook is designed for the beginner in bacteriology. Stress is laid throughout on the fact that bacteria are living organisms, not merely, in some cases, the cause of disease, and a good account is given of their morphology, classification, reproduction,

growth and nutrition and the effects of environment (physical, chemical and biological) on them. The practical aspects of the subject, however, are not neglected and there are chapters on bacteria of the soil, of waters, in sewage disposal, of milk and milk products and on industrial microbiology. Moulds and yeasts are also dealt with in two short chapters. In the last four chapters the relations of bacteria and other micro-organisms to medicine are considered under the headings: The Mechanism of Infection; Immunity and Serum Reactions; Pathogenic Bacteria; and Filterable Virus, Bacteriophage and Rickettsias.

The book is well illustrated and there is a useful glossary of technical terms.

French-English Science Dictionary for Students in Agricultural, Biological and Physical Sciences. By Louis DeVries. Pp. viii + 546, 7 × 5. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 24*s*. 6*d*.

This dictionary should prove very useful to students of the sciences mentioned in the title. It comprises some 43,000 entries, including many literary terms, tenses of irregular verbs and common idioms, as well as purely technical words. It thus serves as a useful guide to those with only a smattering of French. Only the more commonly used names of animals, insects, plants or chemical compounds are given, since as the author rightly states, each of these subjects would need a dictionary of its own. For those desiring fuller information there is a useful list of standard dictionaries and reference works at the beginning of the book.

MINERAL RESOURCES

ARTICLE

METALS OF THE EMPIRE*

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MODERN civilisation has been characterised as "The Age of Metals," though to the cynically-minded a more apposite phrase at the present time might be "The Clash of Metals." But however this may be, metals, and the ores from which they are obtained, play a fundamental and decisive part in both peace and war, and doubtless will continue to do so for generations to come, despite spectacular advances made in the plastics industry and in the field of non-metallic minerals.

The metals which enter so largely into industry do not number more than about a couple of dozen, yet the problems confronting the metal trades are manifold and it will only be possible to give here a brief résumé of the metal and ore position of the British Empire, which is essentially sound. Although problems of procurement naturally arise from time to time, the Empire war-time potential for essential minerals is outstanding, and, especially if augmented by that of the United States, far exceeds that of the enemy. The peace-time value of the Empire's output of metallic ores was of the order of £230 million, of which the United Kingdom, the Dominions, India and Burma contributed nearly £200 million, the Colonies and Protectorates £30 million, and the Mandated Territories £3 million. Details of our share of mineral wealth may be gleaned from Table I, which shows that the Empire accounts for more than four-fifths of the world's production of nickel, about two-fifths that of tin, and roughly one-third of the outputs of lead, zinc, manganese, copper and chrome ores. Over half of the world's production of gold comes from Empire sources.

Much progress has been made since the last war in the Empire's smelter contribution of unwrought metal to industry generally. During the period 1914-1938, as may be seen from Table II, the Empire's output of copper and aluminium increased six-fold, that of zinc five-fold, whilst the production of lead was nearly trebled.

* Specially prepared for the British Empire Number of *Chemistry and Industry*, April 26, 1941 and reprinted by kind permission of the Editor.

If more up-to-date statistics were available for publication the increases would doubtless be considerably greater. Improvement and economies effected in mining, concentrating and refining practice have led to a pronounced fall in production costs and hence in selling price during the last quarter of a century. Thus in Canada electrolytic copper fell from about 26 cents to just over 10 cents per lb.; lead from 8·5 cents to just over 3 cents; zinc from 8 cents to 3·1 cents; and nickel from $36\frac{1}{3}$ to $22\frac{1}{2}$ cents. It has been estimated that the saving to the Home Government in regard to purchases of these metals from Canada will be about \$75-\$90 million per annum as compared with similar purchases in 1918.

Iron and Steel

The outbreak of war found the Empire with a steel capacity of more than 20 million tons per annum, with steel industries established in the Dominions and India mostly able to supply their own requirements and also to contribute effectively to the production of munitions. At home in Britain recent years have seen the further development of the enormous iron ore deposits of eastern England and the continued expansion of the use of basic steel. The basic Bessemer process with soda-ash desulphurisation has been introduced at Corby, and larger blast furnaces with a capacity of 500 tons per day and improved efficiency have replaced many older units. Under the pressure of war needs, iron-ore mining has increased considerably, the major fields being extended and abandoned deposits reopened so that production in 1940 was a record, even exceeding that of the eighteen-eighties. For high-grade ores, however, Britain depends largely on imports, and with the loss of supplies from Europe and North Africa the value of Empire supplies has been fully realised. Nearest to hand are the Wabana mines of Newfoundland, which have exported more than 35 million tons of phosphoric haematite during the last 45 years. For non-phosphoric ore the resources of Sierra Leone are available from the Marampa deposits, opened up in 1933, whose yearly exports were approaching the million ton level just before the war began. South Africa also is now supplying us with considerable quantities of high-grade ore.

Canada's steel industry is based primarily on iron ore imported from Newfoundland and across the Great Lakes from the United States, but encouraged by a Government bounty, iron mining was resumed in 1939 after a lapse of many years. In Ontario the New Helen Mine is now a substantial producer of sintered siderite ore, and an important deposit of good haematite, located by geophysical methods in 1938, is being opened up at Steep Rock Lake. The production of both pig iron and steel ingots in 1940 was considerably greater than in 1939.

Australia, India and South Africa have important growing steel industries based on large and accessible deposits of iron ore. India

also produces for export very good pig iron, high in manganese and low in phosphorus, and leads the world in this trade so that during last year large shipments to Britain were easily arranged. South Africa has the youngest steel industry in the Empire but already produces more than a third of her steel requirements, and New Zealand is now to build a government steel plant. Malaya produces about two million tons of iron ore a year, all of which is exported to Japan.

Ferro-Alloy Metals

The steel metallurgist of to-day is largely concerned with improving the quality of his product to meet the ever increasingly stringent demands of the engineer, and here the ferro-alloy metals play a vital part. Great Britain has, unfortunately, only insignificant resources of these metals, but the Empire possesses them in abundance and variety.

Canada has the unique nickel deposits of Sudbury, Ontario, which supply 85 per cent. of the world's output. Increased output is planned and the capacity of the ore-concentrating plant was increased considerably in 1940. India is the leading exporter of manganese ore and produces high-grade chromite in Baluchistan and rutile in Travancore. Burma is second only to China in her output of wolfram and is also a producer of nickel-cobalt speiss. Australia is an important producer of tungsten ores, particularly scheelite, as well as of tantalite and rutile. South Africa supplies large quantities of manganese ore and chromite. Southern Rhodesia is one of the largest producers of chromite in the world, and Northern Rhodesia now leads the world in cobalt production as a by-product of her copper industry and is also an important producer of vanadium. West Africa is also important as shown by the exports of manganese ore from the Gold Coast and of columbite from Nigeria. This list is admittedly incomplete, though the only mineral of the ferro-alloy group in which Empire production is deficient is molybdenite; fortunately the United States, which produces 90 per cent. of the world's output, can supply all our needs. Our consumption of molybdenum, however, is not so high as that of some countries where it is used to reduce the consumption of other imported ferro-alloy metals such as tungsten and nickel. The Empire's great wealth of ferro-alloy minerals furthermore provides a valuable basis for export trade to the United States and other friendly powers. At the same time, by withholding supplies from our enemies, we are able to increase the superiority of our machines over theirs.

With all these ores available it is disappointing to find that in the past we have not been self-sufficient in our ferro-alloy industry. For the alloys manufactured in the blast furnace the position is satisfactory, and all the Empire steel producing countries, for example, now make their own ferro-manganese. It is in the manu-

facture of low-carbon ferro-chromium and ferro-manganese, in the refining of cobalt and in other electrometallurgical processes that the position is less satisfactory. Canada's electrometallurgical industry has been expanded, and Australia has recently undertaken the manufacture of a wide range of ferro-alloys, including both low-carbon and carbon-free, but the production of these alloys in conjunction with calcium carbide in the United Kingdom, or with aluminium, for instance, in one of the Colonies, is a matter worthy of careful consideration.

Base Metals

Foremost of the base-metals in topical interest is copper, Empire supplies of which have increased in such a remarkable manner since the last war, that exportable surpluses of this former "deficiency commodity" are available in normal times. Large and comprehensive schemes have been put into operation to enable the copper industry to play its full part in the present war economy, and notable increases in output are doubtless to be expected from Canada, Northern Rhodesia, Australia, the Union of South Africa and India.

The Empire is the world's largest producer of tin and enjoys a valuable export trade in this commodity, even under war conditions. The chief contributors are Malaya (the world's largest producer and smelter of tin ore), Nigeria, Burma, Australia and the United Kingdom. Much has been done to modernise the industry, especially in the Federated Malay States, while in South Wales the first continuous hot-strip mill began operations in 1939. This plant is stated to be able to produce 600,000 base boxes of tin plate per week.

Large supplies of lead and zinc are available from various parts of the Empire, particularly Australia, Canada and Burma, as well as from the United Kingdom. Stocks of lead on hand in 1939 resulting from the reduction agreement of the Lead Producers' Association were liquidated by the producers entering into contracts with the British Government after the outbreak of war. Considerable purchases of zinc have been made, the "Anderson" air-raid shelter programme in particular causing a large demand for heavy-gauge galvanised steel.

The Empire's resources of cadmium, chiefly from Canada and Australia, are believed to be adequate for essential needs. Arsenic and bismuth are metals for supplies of which the Empire depends in some measure on foreign countries. Antimony is normally one of our "deficiency commodities," but the position has been considerably improved during the past few years, especially in Canada, the Union of South Africa and Burma. An excellent regulus is stated to be made at the new plant of the Consolidated Mining and Smelting Co., Ltd., at Trail, British Columbia.

LIGHT METALS

The rapid development in aircraft design and construction during recent years has made ever increasing demands on the light metal and alloy industries of the Empire. The war-time production of aluminium in Canada and the United Kingdom constitutes a record, and schemes have already been advanced for the reduction of the metal in India and Australia. Although the capitulation of France cut off important supplies of French bauxite (the principal ore from which aluminium is obtained), the Empire was fortunate in possessing large deposits of first-class bauxite being worked extensively in British Guiana, as well as important reserves in India, Australia, Gold Coast, Nyasaland and Malaya. Extensive deposits of alunite also occur at Chandler Lake and Lake Campion in Western Australia, and are under investigation for the production of the metal and a potash fertiliser. The United Kingdom cannot claim to be well endowed with domestic deposits of bauxite, but vast quantities of china clay are nevertheless available from which aluminium could be produced in case of emergency.

Strenuous and successful efforts have been made in the United Kingdom during the past few years to build up an adequate magnesium industry from such raw materials as magnesite, dolomite and sea-water. In 1938 the estimated production of metal was 3,000 tons, but this has been considerably increased to meet war needs, and Great Britain is now the world's second largest producer. The possibility of producing metallic magnesium in Canada from brucite deposits in Ottawa and Quebec has been investigated, whilst a plant is to be erected in Tasmania to produce 1,000 tons of metal per annum from domestic ore. Great Britain has abundant supplies of dolomite, and extensive deposits of magnesite occur and are worked in India, Australia, the Union of South Africa, and Kenya.

The exceptionally lightweight metal, beryllium, is commanding increasing attention both from a metallurgical and a chemical point of view. Unlike aluminium and magnesium, it does not appear to be of value in the manufacture of light and ultra-light alloys for aircraft construction, but it is, nevertheless, of particular interest for imparting heat-treatable characteristics to copper, nickel, cobalt and iron. Beryllium-bronzes are used for heavy-duty bearings, valve seatings and guides, and various safety tools for use in gas works, coal mines and petroleum refineries. Springs made of 2¼ per cent. beryllium-copper alloy heat treated at 260° C. withstand many million flexures and are mechanically superior to those made of phosphor-bronze. They are resistant to corrosion (e.g. salt spray) and are good conductors of electricity. So far no metallic beryllium has been produced commercially within the Empire, and supplies have consequently been drawn from U.S.A. Supplies of beryl or beryllium ore are available in India and Canada and deposits are known to occur in South Africa. Schemes are in hand for the production of beryllium oxide and metal in Canada.

Precious Metals

In 1913 more than 90 per cent. of the world's output of platinum metals came from Russia, but by 1934 Canada's output as a by-product from the refining of the Sudbury nickel-copper ores had exceeded 200,000 oz. annually—more than that of all the other producing countries put together. South Africa has, within recent years, also become an important producer of platinum metals, occurrences of which have been discovered since 1922 in the Waterberg, Lydenberg, Potgietersrust and Rustenburg districts. Osmiridium is produced on a considerable scale as a by-product from the Rand gold mines, and a small but nevertheless useful contribution to our total production comes from Australia. Great Britain possesses the largest platinum metals refinery in the world.

The Empire is at present unfavourably placed for supplies of mercury, the normal sources of which are Italy, Spain, the United States, Mexico and China. As, however, the metal is used in the manufacture of drugs and chemicals, of mercury fulminate for detonators, naval anti-fouling paint, in scientific and industrial instruments, and in the gold-amalgamation process, intensive investigations have been carried out with a view to increasing the Empire's output. Already Canada, South Africa and New Zealand are producing on a small though increasingly useful scale. These Empire efforts, coupled with control of consumption at home and the fact that mercury is still obtainable from Spain, have done much to mitigate our supply position. In addition, the United States has not only again been increasing its production, but has also recently adopted a policy of pre-empting the important Mexican output formerly cornered by Japan.

The Empire produces about one-sixth of the world's output of silver, which is mainly obtained as a by-product in the treatment of copper, lead, zinc and gold ores.*

Metals in Chemical Industries

Apart from their well-known metallurgical applications, all the metals already enumerated have important chemical uses, whether in the manufacture of chemical plant or chemical compounds. Industrial wartime regulatory measures have, however, been found expedient to enable supplies of metallic raw materials to be diverted to essential chemical trades. Much progress has been made in the chemical industry of the United Kingdom and the Dominions in utilising domestic materials to an increasing degree.

Tantalum, essentially an Empire metal, is widely used for corrosion-resistant chemical plant, and as an alternative to the platinum-gold or palladium-gold spinnerets used in the production of artificial silk by the viscose process. Titanium, in the form of

* Gold was the subject of a separate article in the British Empire Number of *Chemistry and Industry*.

titanium white, manufactured from ilmenite from India, the world's largest producer of the mineral, is an important white pigment especially for black-out use. Again, Empire platinum and alloys are of the utmost importance to the industry, not only in electrical instruments, but also as catalysts, particularly in the oxidation of ammonia to nitric acid and in the production of sulphuric acid by the contact process. Other outstanding examples of metallic catalysts include the use of African vanadium in the manufacture of contact sulphuric acid, of Canadian nickel in the hydrogenation of oils and fats for the production of margarine and of Rhodesian cobalt, and Indian thorium in the Fischer-Tropsch process for the production of synthetic petrol.

Compounds of metals enter into many important pigments such as white lead, lithopone, zinc white, barytes, cobalt blue, cadmium yellow, and ultramarine. Many metals and alloys are used in the construction of chemical plant, and amongst these perhaps lead, copper, chrome and nickel steels and silicon cast iron may be mentioned. There is little object here in enumerating any of the applications of metallic salts utilised on a larger or smaller scale in the industry, suffice it to say that they enter into every modern industrial process.

Conclusion

Sufficient has been said in the above brief outline to indicate the Empire's preponderance of mineral and metal wealth. But, though nature may be prodigal with her gifts, minerals and metals are not necessarily available in any quantity and at any moment merely for the asking. The location and assessment of mineral deposits, their exploitation and subsequent metallurgical treatment are matters requiring time and often the utmost skill and ingenuity. It cannot, therefore be too strongly emphasised that in order to keep production abreast with the assumed consumption at any given period during the exigencies of war, vigilance and planned co-ordination of a high degree should be exerted and maintained.

Table I—Production of the Chief Metallic Ores (excluding Gold)

(*Long tons*)

Ore.	World Total 1938.	British Empire Total.		British Empire per cent. in 1938.	Chief Contributors to Empire total in 1938.
		1914.	1938.		
Bauxite	3,990,000	9,000	634,000	15·9	British Guiana, 563,000; Unfederated Malay States, 55,000; India, 15,000.
Antimony (Sb content)	36,000	1,000	650	1·8	Australia, 450
Cadmium	4,700	—	750	16·0	Canada, 312; Australia, 196; United Kingdom, 123; South-West Africa, 114.

TABLE I—PRODUCTION OF THE CHIEF METALLIC ORES (EXCLUDING GOLD)—*contd.*

(*Long tons*)

Ore.	World Total 1938.	British Empire Total. 1914.	British Empire Total. 1938.	British Empire per cent. in 1938.	Chief Contributors to Empire total in 1938.
Chrome ore	1,130,000	50,000	409,000	36·2	Southern Rhodesia, 183,000; Union of South Africa, 174,000; India, 44,000.
Cobalt ore (Co content)	3,800	400	1,800	47·4	Northern Rhodesia, 1,438; Burma, 202; Canada, 205.
Copper ore (Cu content)	2,020,000	86,000	600,000	29·7	Canada, 255,000; Northern Rhodesia, 251,000; Cyprus, 36,000; Australia, 19,000.
Iron ore	165,000,000	16,300,000	21,500,000	13·0	United Kingdom 11,859,000; India, 2,744,000; Australia, 2,250,000; Newfoundland, 1,680,000; Unfederated Malay States, 1,581,000; Sierra Leone, 862,000; Union of South Africa, 497,000.
Lead ore (Pb content)	1,780,000	300,000	631,000	35·4	Australia, 274,000; Canada, 187,000; Burma, 88,000; Newfoundland, 31,000; United Kingdom, 30,000; South-West Africa, 18,000.
Magnesite*	1,800,000	4,000	50,000	2·8	India, 26,000; Australia, 20,000.
Manganese ore	5,800,000	690,000	1,870,000	32·2	India, 968,000; Union of South Africa, 543,000; Gold Coast, 324,000.
Molybdenum ore* (MoS_2 content)	27,000	70	50	0·2	Australia, 45.
Nickel ore (Ni content)	113,000	20,300	95,100	84·2	Canada, 94,000
Silver ore (*fine oz.*)	*267,000,000*	*43,000,000*	*48,400,000*	18·1	Canada, *22,219,000*; Australia, *15,552,000*; Burma, *5,920,000*; Newfoundland, *1,646,000*; Union of South Africa, *1,135,000*.
Tin ore (Sn content)	159,000	68,000	64,000	40·3	Federated Malay States, 41,200; Unfederated Malay States, 2,000; Nigeria, 9,000; Burma, 4,400; Australia, 3,300.
Zinc ore (Zn content)	1,830,000	180,000	540,000	29·5	Australia, 220,000 Canada, 179,000; Newfoundland, 66,000; Burma, 55,000; Northern Rhodesia, 12,500; United Kingdom, 11,500.

* *Estimated.*

TABLE II—PRODUCTION OF METALS (EXCLUDING GOLD)
(*Long tons*)

Metal.	World Total 1938.	British Empire Total.		British Empire per cent. in 1938.	Chief Contributors to Empire total in 1938.
		1914.	1938.		
Pig-iron and ferro-alloys .	91,000,000	9,940,000	10,310,000	11·3	United Kingdom, 6,761,000; India, 1,571,000; Australia, 927,000; Canada, 761,000; Union of South Africa, 290,000.
Steel ingots and castings	106,000,000	8,700,000	13,900,000	13·1	United Kingdom, 10,398,000; Australia, 1,166,000; Canada, 1,155,000; India, 936,000; Union of South Africa, 295,000.
Copper .	2,010,000	75,000	468,000	23·3	Northern Rhodesia, 213,000; Canada, 212,000.
Lead . .	1,620,000	173,000	495,000	30·6	Australia, 223,000; Canada, 179,000; Burma, 80,000.
Zinc . .	1,540,000	55,000	289,000	18·8	Canada, 154,000; Australia, 70,000; United Kingdom, 55,000; Northern Rhodesia, 10,000.
Aluminium .	579,000	14,000	88,000	15·2	Canada, 65,000; United Kingdom, 23,000.
Tin . .	163,000	80,000	103,000	63·2	British Malaya, 64,000; United Kingdon, 36,000; Australia, 3,000.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from Reports made to the Dominions, Indian and Colonial Governments

RECENT DISCOVERIES OF GORCEIXITE IN THE EMPIRE

AMONG the numerous samples forwarded to the Imperial Institute from Empire sources during recent years for report and identification, three have been shown to consist of the interesting mineral known as gorceixite. This mineral, named after Professor Henri Gorceix, the first Director of the School of Mines, Ouro Preto, consists of a basic phosphate of aluminium and barium with smaller amounts

of calcium and rare earths. It has previously been described only from Brazil, where it occurs in small, bean-like pebbles or " favas " (Portuguese, " bean ") in the diamond sands of Minas Geraes. The material has no economic value in itself, but is usually regarded as a good " indicator " of the presence of diamonds in a deposit. In this connection it is interesting to note that the new occurrences are also in diamantiferous areas, and are as follows :

(1) Gold Coast—diamantiferous gravels of the Bonsa River, near Dompim.

(2) Sierra Leone—diamantiferous gravels of the Oiyi District (No. 1 Pan Plant).

(3) British Guiana—diamond workings, Issineru, Mazaruni District.

To Dr. N. R. Junner, Director of the Gold Coast Geological Survey, belongs the credit for the discovery of the mineral in both the Gold Coast and Sierra Leone. The British Guiana material was forwarded by Mr. S. Bracewell, B.Sc., A.R.C.S., D.I.C., Director of the Geological Survey of British Guiana.

The following Imperial Institute report is confined solely to the favas discovered in the Oiyi gravels of Sierra Leone by Dr. Junner in 1937 and referred to in the *Report of the Gold Coast Geological Survey Department* for the financial year 1939-40, pp. 15-17. The mineralogical examination and identification of the specimens as well as the compilation of the report were done by Mr. E. H. Beard, B.Sc. (Lond.) ; the chemical analyses were carried out by Mr. W. H. Bennett, M.Sc. (Lond.), A.I.C.

Gorceixite from Sierra Leone

The sample which is the subject of this report weighs about ½ oz. and consists of a number of small rolled pebbles or " favas " varying in diameter from 4 to 8 mm. They may be divided into three types, viz. :

(1) Greyish-white porcellaneous-looking favas consisting essentially of gorceixite.

(2) Dark brown and jasper-like favas consisting essentially of basic aluminium-barium phosphate.

(3) Favas consisting of brown centres of basic aluminium-barium phosphate surrounded by white or buff gorceixite.

Nearly all the above favas possess an extremely thin greyish-black " skin " of indeterminate character. No fava was observed in this sample corresponding to those previously received from the Gold Coast in which the centre portions were white or buff-coloured and the outer portions of a dark brown to reddish brown colour. Detailed descriptions of the first two types are given below; the third type, being apparently a mixture of the brown and white materials, has not been separately described.

(1) *Greyish White Favas*

These have a semi-conchoidal fracture and a hardness of about 6. Under the microscope crushed fragments are seen to be irregular to rudely prismatic in outline, and, when highly magnified ($\frac{1}{12}''$ oil immersion objective), to be cryptocrystalline to microcrystalline in structure, individual components being greyish white to colourless and of weak birefringence. A few minute crystals give straight extinction and yield a uniaxial interference figure, thus showing that the mineral is either hexagonal or tetragonal in crystalline form. The refractive index of the material, as determined by the immersion method, is about 1·62. The specific gravity is 3·07. A representative sample of the material on chemical analysis was found to have the following composition:

Analysis of Greyish White Favas

		Per cent.	Molecular Weight.	Molecular Proportion.
Phosphoric anhydride	P_2O_5	22·75	142	0·160
Alumina	Al_2O_3	30·95	102	0·303
Ferric oxide	Fe_2O_3	1·02	160	0·006
Barium oxide	BaO	18·07	153·5	0·118
Lime	CaO	2·17	56	0·039
Thoria and rare earth oxides	—	2·00	156*	0·013*
Magnesia	MgO	0·08	40	0·002
Silica	SiO_2	5·77	60	0·096
Titania	TiO_2	0·30	80	0·004
Sulphuric anhydride	SO_3	1·00	80	0·013
Fluorine	F	0·20	19	0·011
Loss on ignition	—	16·17	18†	0·898†
		100·48		
Less O=F		0·08		
Total		100·40		

* *Calculated as CeO for comparative purposes.*

† *Calculated as H_2O. Owing to the small amount of material available it was not possible to determine the combined water and this figure is probably high on account of the loss of some volatile constituent, such as SO_3, on ignition.*

If, following the example of E. Hussak (see *Min. Pet. Mitt.*, **25**, 1906), assumed impurities are deducted from the analysis and the

remainder recalculated to a percentage basis, it will be seen that the material approximates closely in composition to that expressed by Hussak's original formula for gorceixite, namely (Ba, Ca, Ce)O. $2Al_2O_3$. P_2O_5. H_2O. There seems little doubt, therefore, after considering the physical and chemical characteristic of the greyish white favas, that they consist essentially of gorceixite.

ANALYSES OF GORCEIXITE

	1.	2.	3.	4.	5.	6.
P_2O_5	22·74	21·47	18·33	22·75	27·76	24·11
Al_2O_3	35·00	35·20	40·56	30·95	29·91	34·60
Fe_2O_3	4·10	1·67	2·30	1·02	—	—
BaO	15·42	15·30	13·84	18·07	30·01	26·02
CaO	3·55	2·24	1·81	2·17		
CeO	1·55	2·35	—	2·00*		
MgO	—	—	—	0·08	—	—
MnO	—	—	—	—	—	—
Na_2O	—	—	3·75	—	—	—
SiO_2	1·55	6·50	3·54	5·77	—	—
TiO_2	0·67	0·75	—	0·30	—	—
SO_3	—	—	—	1·00	—	—
F	—	—	0·40	0·20	—	—
H_2O+	14·62	14·73	14·89	16·17†	12·32	15·27
H_2O-	—	—	0·65	—	—	—
Total	99·20	100·21	100·07	100·48	100·00	100·00
Specific gravity	3·101	3·098	2·99	3·07	—	—

* *Thoria and rare earth oxides.*

† *Loss on ignition.*

1 & 2. Barium-aluminium-phosphate favas from Rio Abaëtè; Analyses by G. Florence. See "Über die sogenannten 'Phosphat-Favas' der diamantführenden Sande Brasiliens," by Eugen Hussak. *Tschermak's Mineralogische und Petrographische Mitteilungen*, 1906, **25**, 337.

3. Favas from Minas Geraes; Analysis by H. W. Nichols. See "Studies of Brazilian Favas," by Oliver C. Farrington. *American Journal of Science*, 1916, **41**, 356.

4. Present sample (greyish white favas) from Oiyi No. 1 Pan Plant, Sierra Leone; Analysis by W. H. Bennett, M.Sc. (Lond.), A.I.C., Imperial Institute.

5. Theoretical composition of gorceixite according to W. T. Schaller's formula $[Al(OH)_2]_6$. $Ba[HPO_4]_2$. $[Ba(PO_4)_2]$. See *Handbuch der Mineralogie*, by Carl Hintze, 1933, Vol. 1, Pt. 4, p. 1151.

6. Theoretical composition of gorceixite according to Hussak's formula (Ba, Ca, Ce)O. $2Al_2O_3$. P_2O_5. $5H_2O$. For the purpose of calculation it is assumed that the percentages of lime and ceria are negligible.

(2) *Dark Brown and Jasper-like Favas*

These pebbles have a specific gravity of 2·95, and a refractive index of about 1·63 which is somewhat higher than that of the greyish white favas. They are essentially cryptocrystalline in character, their brownish colour apparently being due to iron oxide, rather than to ceria as suggested by Hintze (*op. cit.*) for gorceixite

favas of similar appearance. A chemical analysis of representative material gave the following results:

		Per cent.	Molecular Weight.	Molecular Proportion.
Phosphoric anhydride	P_2O_5	23·29	142	0·164
Alumina	Al_2O_3	29·01	102	0·284
Ferric oxide	Fe_2O_3	2·89	160	0·018
Barium oxide	BaO	18·41	153·5	0·120
Lime	CaO	2·49	56	0·044
Thoria and rare earth oxides	—	0·52	156*	0·003*
Magnesia	MgO	0·07	40	0·002
Silica	SiO_2	6·24	60	0·104
Titania	TiO_2	0·25	80	0·003
Sulphuric anhydride	SO_3	0·75	80	0·009
Fluorine	F	0·30	19	0·016
Loss on ignition	—	16·23	18†	0·902†
		100·45		
Less O=F		0·13		
Total		100·32		

* *Calculated as CeO for comparative purposes.*

† *Calculated as H_2O. Owing to the small amount of material available it was not possible to determine the combined water, and this figure is probably high on account of the loss of some volatile constituent, such as SO_3, on ignition.*

This mineral therefore also approximates rather closely in composition to gorceixite but differs a little from the greyish white material in having an increased iron oxide content (at the expense of alumina) and a considerably lower rare earth content. Nevertheless the molecular proportions of (Ba, Ca, Ce)O : P_2O_5 : Al_2O_3 : H_2O are still close to those in Hussak's formula, i.e. 1 : 1 : 2 : 5.

The brownish variety sometimes forms the core of a pebble of which the outer portion is greyish white, and this rather militates against the suggestion that it is an alteration product. The low ceria content and slightly higher refractive index indicate some abnormality, but it would be premature to suggest that it is a new mineral. Its exact nature remains a little doubtful owing to the small quantity of material available and the unsatisfactory results obtained by microscopic examination. Should more and better material, however, be obtainable, it may be possible to throw further light on the problem.

PROGRESS IN COLONIAL MINERAL INDUSTRY

MALAY STATES (FEDERATED)

The following data for the last quarter of 1940 have been compiled from returns furnished by the Chief Inspector of Mines.

PRODUCTION OF TIN-ORE
(October to December 1940)

State.	Metal content.	Value.
	(*Long tons.*)	(£.)
Perak	12,307	3,200,518
Selangor	6,823	1,774,741
Negri Sembilan	764	198,682
Pahang	906	235,521
Total	20,800	5,409,462

Other minerals produced were: gold, 9,705 troy oz.; coal, 182,838 tons (all from Selangor); china clay, 121 tons; haematite, 205 tons (all from Perak); wolfram, 13 tons; scheelite, 11 tons.

MALAY STATES (UNFEDERATED)

JOHORE

The following progress report on mining in the State of Johore during the last quarter of 1940 has been compiled from a statement submitted by the Acting Warden of Mines.

Tin Ore.—The production of tin ore continues to be regulated by Tin Restriction and can only correspond to the permitted quota release plus an amount of tin ore sufficient to bring the stocks held at the mines to the full amount permitted under the International Tin Restriction Agreement. Exports cannot be greater than the permitted quota release for each quota period, which corresponds to a quarter of a year.

Exports of tin ore from all sources during the period under review amounted to 394·4 tons, valued at \$633,902·15 as compared with 435·6 tons valued at \$700,097·68 during the third quarter of 1940.

The proportion of the total exports of tin ore from mines owned or managed by Europeans was 52·66 per cent. during the last quarter of the year as compared with 61·26 per cent. during the third quarter.

Iron Ore.—Exports of iron ore for October amounted to 60,403·4 tons, for November 44,902 tons, and for December 40,658·8 tons, making a total export of 145,964·2 tons valued at \$729,821. The exportation of ore from the East Coast ceased at the end of October owing to the incidence of the monsoon season, and from Endau the tonnage exported during the quarter amounted to 34,868·8. From Batu Pahat (West Coast) 111,095·4 tons were exported.

Bauxite.—The Kim Kim Mine, which is situated near Pulau Nanas on the south coast of Johore, was not operated during the quarter, but further prospecting and valuation was done on the ore deposit. From other mines the bauxite exported amounted to 13,074·26 tons, valued at $65,371·3, the whole of which went from Batu Pahat on the west coast.

Gold.—There was no production of gold during the period under review.

NIGERIA

Geological Survey

The following report on the work carried out by the Geological Survey during the period January to December 1940 has been received from the Director.

Gold.—A survey has been made of Pategi Emirate in Ilorin Province, where gold is being won both from alluvials and from reefs. The southern half of the emirate is underlain by a complex of crystalline rocks while in the north there is an extensive outcrop of younger sedimentary rocks known as the Nupe Sandstones. The crystalline complex consists of ancient schists and para-gneisses, amphibolites and granulites, together with a younger group of ortho-gneisses and granitic intrusions with associated pegmatites and quartzose vein rocks.

Eluvial gold is widespread and it is possible to obtain "colours" almost anywhere over the schists and para-gneisses by washing a few headpans of soil and eluvial detritus. Most of this gold is angular and has, therefore, not travelled far from the source reefs and stringers. Alluvial gold is being won chiefly from small tributary streams with rocky beds. Conglomerates at or near the base of the Nupe Sandstones sometimes yield gold. Exposures of these conglomerates are rare in the main outcrop of the sandstones in the north of the emirate but sandstone outliers and residual deposits in the south-east are worthy of the attention of prospectors.

Some auriferous quartz reefs are at present being worked in the emirate. All the reefs are more or less vertical and there is no evidence of saddle reef formation. The gold is associated with pyrite and galena. Earthy pyromorphite is common as a greenish-yellow coating on the quartz, and occasional crystals of crocoite also occur.

On one lease gold is being won from a band of soft muscovite-schist at its junction with an intrusive amphibolite. No quartz reef or stringer is present but there are some tiny veinlets of quartz in the schist.

Wolfram.—Certain lodes in southern Kano and western Bauchi Provinces were investigated. Most of the workings along the lodes have reached the limit of mining from the surface and the lenses of rich ore have been cleaned up by tributers. This made it impossible to arrive at a sound estimate of the total ore values. An electrical method of prospecting was tried without success. The

only way to determine the relative amount of good ore to lodestuff is to drive along the lodes for several hundred feet. The lodestuff was examined in some detail, but it was found that the amount of wolfram it contains is negligible. In the case of the Kano lode, however, much of the lodestuff is a low-grade but probably payable tin ore.

Limestone.—An investigation of the Cretaceous strata of Benue Province was made in order to determine whether a limestone could be found near the railway line suitable for the production of cement for use in the Eastern Provinces. Several limestone outcrops were discovered and those which, having regard to quality, quantity and distance from the railway, appear to be most promising for the purpose in view were examined in some detail. Specimens of limestone and shale were collected and after preliminary examination in the laboratory representative samples were sent to the Imperial Institute for trial burning. Tests are to be made in the first instance to determine whether an artificial pozzolana can be prepared from the shale and used in conjunction with lime from one of the limestones.

Geology of Sokoto Province.—The survey of the 23,000 sq. miles of sedimentary rocks in Sokoto Province has been completed. Rock specimens and fossils collected in the field are now being examined and a report on the whole area is in course of preparation. Among new fossil discoveries made this year were several specimens of *Libyoceras*, the first ammonite to be recorded from Sokoto Province.

Water Supply.—The exploratory borehole at Sokoto was taken to a depth of 870 ft. Several aquifers were found but they all proved to be very fine in grain and gave insufficient supplies of water. An attempt is being made to exploit the most promising aquifers by means of a gravel screen. The screen has already been introduced around the borehole and yield tests are now being made.

The well-sinking programmes have been greatly restricted owing to the calling up of several officers for military service. In areas where European supervision could not be provided, one or more maintenance crews have been retained. During the year 114 new concrete-lined wells were completed.

Mining Activity

The Chief Inspector of Mines has forwarded the following notes and statistics covering the last quarter of 1940.

Nigeria—Mineral Production and Exports, October-December 1940

	Production.	Exports.
	Tons.	*Tons.*
Tin ore	4,115	2,415*
Columbite	105·3156	150
Wolfram	14·9777	17·1697
	Troy oz.	
Gold (900 fine)	6,573·29	—

* *Customs figures of ore shipped.*

Tin.—Nigeria's standard tonnage expressed in ore (72·5 per cent. tin) is 15,021 tons. Successive quotas gave a tonnage of 16,523 for the year. According to Custom's figures, the total actually exported in 1940 was 13,773 tons of ore, but railing permits issued by the Mines Department represented over 14,000 tons. Some of this ore will be at the ports waiting for shipping space. A certain amount of the 1940 quota was carried over into 1941 for shipment in accordance with Clause 17 (*b*) of the International Tin Control Agreement. At the close of 1940 excess shipments of ore were reduced to a little over 1,100 tons. These excess shipments arose from a special shipment in 1939 in response to an urgent war demand. Nigeria, therefore, may be considered to have more than fulfilled her obligations for the years 1939 and 1940, and stocks on hand at December 31, 1940, were 3,875 tons as compared with 1,664 tons at the close of 1939.

Gold.—Production in the fourth quarter was less than in the third, but the total for the year—25,617 oz. troy—closely approximated the average for the three preceding years. The standard of prospecting work on Exclusive Prospecting Licences is being improved. There are a multitude of small quartz lodes in the country yet to be sampled.

Columbium.—Export of columbite ore was resumed, 150 tons being shipped. The totals for the year were: production, 396 tons; exports, 250 tons, all to the United States of America. There are ample supplies of this ore available.

Tungsten.—Production and exports were slightly less than in the third quarter. The total won in 1940 was 98 tons; total shipped, 110 tons. Known occurrences of detrital rubble being largely exhausted, the mining of lode outcrops has commenced.

SARAWAK

The Chief Secretary reports that the production of gold for the period June 1 to August 31, 1940, was 3,212 fine oz., of which 30 oz. came from the Kuching District and the remainder from the Bau District. The area covered by Mining Leases at the end of August was 6,733 acres, and, of the 39 leases extant, two cover quicksilver and the remainder gold and silver. Four Exclusive Prospecting Licences for gold and silver, each issued for a term of one year, and covering in all 1,237 acres, were in existence on August 31, 1940.

Five tons of antimony ore were exported during the above-mentioned period.

ABSTRACTS AND NOTES

Obituary—Dr. C. G. Cullis.—It will be with the deepest regret that his many old students and friends will have learned of the death at Hindhead on April 27, 1941, of Charles Gilbert Cullis, D.Sc., F.G.S., M.I.M.M., Professor of Mining Geology at the Royal School of Mines from 1930-1936.

Dr. Cullis was for very many years a member of the Consultative Committee on Precious Metals of the Imperial Institute, which he joined on the amalgamation of the Imperial Mineral Resources Bureau with the Institute, after having been a member of the corresponding committee of the Bureau. Born in 1871 he was educated at King Edward VI School and Mason College, Birmingham, and at the Royal College of Science, London. From 1892 to 1914 he was Demonstrator and Assistant Professor of Geology at the Royal College of Science, and from 1914 until 1930 Professor of Economic Mineralogy at the Imperial College of Science and Technology. In 1930 he became Professor of Mining Geology, and in 1937 was made Emeritus Professor. Recently he had been an active member of the Non-ferrous Metallic Ores Committee of the Ministry of Supply. His publications include Report on the World's Production of Silver for the Indian Currency Committee, 1919; Report on Copper Deposits of Cyprus for the Colonial Office, 1922; Geology and Mineral Resources of Cyprus, 1924; but it is chiefly as a great teacher that he will be remembered.

Dr. Cullis will be sincerely mourned by the many generations of students who passed through his hands, and to whom he was at all times ready to give the benefit of his help and advice. His untiring efforts to place young graduates in suitable positions resulted in many a successful career, while his unfailing sympathy and kindliness endeared him to all who came into contact with him. As one of the leading economic geologists in this country, Dr. Cullis' services as a consultant were much in demand by the mining industry, and his students reaped the benefit of his wide experience, which was all the more valuable because Dr. Cullis possessed the all too rare gift of being able to present his subject in an extremely lucid and interesting fashion.

The Mineral Resources of Burma.—On the basis of recent peacetime statistics, Burma produces about 84 per cent. of the Empire's wolfram, 28 per cent. of our zinc, 18 per cent. of our petroleum, 14 per cent. of our lead, 13 per cent. of our silver and 7 per cent. of our tin concentrates in addition to a considerable range of other mineral commodities. It is evident, therefore, that Burma's contribution to our production of raw materials for the war effort is highly important and a survey of the mineral resources of the country is of topical interest.

In 1924 a review of the mineral deposits of Burma was prepared

by Dr. G. de P. Cotter of the Geological Survey of India, for the Empire Exhibition, a valuable work of reference which is now out of print. Recently, however, this work has been revised by E. L. G. Clegg and incorporates later information on mode of occurrence, tenor, output, new developments and other details which have subsequently come to hand (*The Mineral Deposits of Burma*, by E. L. G. Clegg, Burma, 1939).

Sir Lewis Fermor has also recently surveyed the strategic aspects of the mineral production of the country in relation to the war effort in an article in *Asiatic Review*, 1941, **37**, 154-166, which is in continuation of his survey of India's mineral resources and the war, noticed in this BULLETIN, 1940, XXXVIII, No. 4, p. 481.

From these works by Cotter and Clegg on the nature, location and mode of occurrence of the principal economic minerals of Burma the following abstracts are taken. The tables on pp. 171-172, taken from Fermor's article, not only show Burma's output of minerals, but also compare the present rate and value of production with that during the last war.

Tin and Tungsten.—Quartz veins containing tin and wolfram have been found at intervals over a distance of 750 miles in Burma from the Yengan and Mawmang States of the Southern Shan States through the districts of Kyauksè, Yamèthin, the State of Karenni, Thatôn, Amherst, Tavoy and Mergui. In all these localities the wolfram- and cassiterite-bearing veins are closely associated with biotite-granite bosses which form the core of the ranges of the Indo-Malayan mountain system.

Both wolfram and cassiterite occur very sparingly as accessory minerals in the granite ; they are also found in aplite and pegmatite veins traversing it and in the greisens, the narrow bands of quartz-mica rock formed by the alteration of the granite adjoining the true quartz veins. These modes of occurrence are more of theoretical interest than practical importance and, with the exception of the surface deposits, quartz veins furnish the great bulk of the concentrates from Burma. Mineral-bearing quartz veins are found either in the granite, penetrating its contact with the sedimentary rocks, or enclosed within the latter rocks themselves at no great distance from the granite. The veins were formed by the infilling of fissures and often occur in parallel groups of over-lapping lenses. The lenses themselves are often irregular, thinning out and thickening again, splitting and then reuniting. There is every variation from great veins traceable for miles on the surface to mere stringers. The general strike follows that of the mountain trend, and is N. to N.E. Dips are usually high.

In different parts of Burma the mineral associates of the tin and wolfram are not the same. Beryl has only been found at Byingyi in the Yamèthin district. Tourmaline is common at Mawchi in Karenni, in the Thatôn district, and in parts of Mergui ; in Tavoy it is unknown in conjunction with wolfram or cassiterite.

MINERAL PRODUCTION OF BURMA, 1934-1938

		1934.	1935.	1936.	1937.	1938.	Mean, 1934–1938.	Mean, 1914–1918.
War minerals:								
Petroleum	*gal.*	254,760,070	251,338,974	265,570,120	274,664,365	263,823,265	262,031,359	275,268,745
Lead	*tons*	70,560	70,560	71,915	76,500	78,900	73,687	14,763
Tungsten-ore	,,	3,328	3,837	4,562	4,998	5,343	4,414	3,473
Tin-ore	,,	5,801	5,860	6,495	6,622	6,303	6,216	599*
Silver	*oz.*	5,792,019	5,825,913	5,952,000	6,180,000	5,920,000	5,933,986	966,301
Zinc-ore concentrates	*tons*	68,838	78,590	76,807	73,552	60,744	71,706	2,395
Copper-matte	,,	11,000	8,950	7,500	7,750	5,900	8,220	459†
Nickel-speiss	,,	3,951	4,850	4,325	4,020	3,015	4,032	—
Salt	,,	36,976	40,086	32,272	53,813	38,698	40,369	39,059
Antimonial lead	,,	1,255	1,500	1,240	1,150	1,200	1,269	234‡
Gold	*oz.*	890	1,483	1,439	1,004	1,209	1,205	2,024
Iron-ore	*tons*	23,930	23,085	26,316	25,426	18,050	23,361	21,302
Bismuth	*lb.*	—	224	112	246	nil	116	—
Molybdenite	*cwt.*	—	—	—	—	—	—	8
Platinum	*oz.*	—	—	—	—	—	—	14
Non-war minerals:								
Building materials	*tons*	2,237,440	1,530,969	2,065,352	3,126,587	2,545,098	2,301,089	982,155
Ruby, sapphire and spinel	*carats*	21,775	105,642	155,553	161,700	212,827	131,499	225,672
Jadeite	*cwt.*	2,094	1,265	1,671	2,952	1,303	1,857	4,651
Clay	*tons*	21,213	25,898	20,355	18,092	18,066	20,725	7,738
Soapsand	,,	6,174	9,525	15,015	19,224§	9,616§	11,910	—
Amber	*cwt.*	4	19	32	39	—	19	18

* *Includes some block tin.* † *Copper ore.* ‡ *Antimony ore.* § *Estimated from value.*

VALUE OF MINERAL PRODUCTION OF BURMA, 1934-38

	1934.	1935.	1936.	1937.	1938.	Mean, 1934-1938.	Mean, 1914-1918.
War minerals:	£	£	£	£	£	£	£
Petroleum	3,629,852	3,749,135	3,736,805	4,474,147	3,766,810	3,871,350	1,025,053
Lead	787,859	1,010,414	1,269,262	1,801,719	1,226,913	1,219,233	358,469
Tungsten-ore	284,956	296,693	307,624	603,214	607,424	419,982	461,698
Tin-ore	764,688	763,081	780,689	824,001	589,042	744,300	73,300*
Silver	559,736	766,524	516,660	553,458	513,670	582,010	135,844
Zinc-ore concentrates	201,309	285,666	303,356	409,054	229,698	285,817	5,526
Copper-matte	165,404	199,715	151,126	181,839	120,230	163,663	881†
Nickel-speiss	86,401	105,269	111,489	104,590	82,561	98,062	—
Salt	40,144	39,925	37,257	62,026	44,329	44,736	188,630
Antimonial lead	15,617	27,065	26,036	31,652	22,096	24,493	157‡
Gold	4,756	8,689	7,820	6,333	7,846	7,089	7,866
Iron-ore§	7,197	6,943	7,915	7,647	5,388	7,018	5,682
Bismuth	—	16	8	18¶	—	8	—
Molybdenite	—	—	—	—	—	—	178
Platinum	—	—	—	—	—	—	76
Total . . . £	6,547,919	7,259,135	7,256,047	9,059,698	7,216,007	7,467,761	2,263,360
Non-war minerals:							
Building materials	149,328	120,995	158,211	194,550	183,182	161,253	68,779
Ruby, sapphire and spinel	2,733	8,601	7,319	7,069	11,006	7,346	41,817
Jadeite	12,501	14,522	13,412	13,030	4,320	11,557	74,498
Clay	1,669	2,116	1,540	1,367	1,477	1,634	529
Soapsand	637	763	1,092	1,602	801	979	—
Amber	12	158	409	668	—	249	280
Total . . . £	166,880	147,155	181,983	218,286	200,786	183,018	185,903
Total, all minerals . . £	6,714,799	7,406,290	7,438,030	9,277,984	7,416,793	7,650,779	2,449,263

* *Includes some block tin.* † *Copper ore.* ‡ *Antimony ore.* § *Value estimated at Rs. 4 per ton.* ¶ *Estimated.*

Eluvial deposits near the granites yield both cassiterite and wolfram, but as the latter mineral disintegrates and decomposes rather easily it is never found in association with cassiterite in the large alluvial tracts. Therefore, whereas tinstone concentrates are obtained by the dredging and hydraulicing of alluvial deposits, mixed tin and wolfram concentrates are won by the washing down of eluvial deposits derived from adjacent ore-bearing veins and by lode-mining.

Mining is carried on at scores of localities, although when wolfram prices are low practically the whole of the Burma wolfram production comes from the Tavoy district and the Mawchi mines of Karenni. The following table shows the production by districts during 1938 arranged in order from south to north.

PRODUCTION OF TIN AND TUNGSTEN DURING 1938

District.	Tin Concentrates (*Tons.*)	Tungsten Concentrates (*Tons.*)	Mixed Tin-Tungsten Concentrates (*Tons.*)
Mergui	1,889	298	—
Tavoy	2,550	3,057	—
Amherst	37	1	—
Thatôn	3	97	—
Karenni	—	—	4,646*
Yamèthin	39	394	58
Southern Shan States	1	2	—
Total	4,519	3,849	4,704

* *Containing* 1,784 *tons metallic tin and* 1,494 *tons tungstic oxide* (WO_3).

In the Mergui district there are widely scattered alluvial deposits of cassiterite, mainly worked by native methods. The best known workings are at Thabawleik on the Little Tenasserim, where a dredge operates; the Lenya river, for work on which a dredge was under construction in 1939; the Pakchan river; Palauk and Karathuri on the coast; and Maliwun. The chief wolfram-producing areas occur near Palauk, Tagu, Wunna, Yengan and Maliwun.

The Thabawleik alluvial deposits appear to derive their cassiterite from numerous quartz veins in the Mergui series. Neither granite nor pegmatite occurs in the vicinity. Maliwun, on a tributary of the Pakchan river, is one of the best known tin-bearing areas of Mergui. The concentrates carry a little wolfram and there are also lodes in the vicinity. The Palauk river area yields mixed concentrates of wolfram and cassiterite, the lodes lying partly in granite and partly in the Mergui series. The beach of Spider Island at the mouth of the river yields a concentrate of equal amounts of tin ore and wolfram.

Tavoy is the predominant wolfram-producing district of Burma. The Hermyingyi mine has long been a big producer of mixed concentrates from veins which range up to 5 ft. in thickness and are worked in both the granite and the Mergui series. At Pagaye a

system of veins and cross veins of wolfram and cassiterite-bearing pegmatite occur. The ores are obtained by both lode mining and hydraulicing of eluvial and alluvial deposits. The Widnes wolfram mine is mainly a lode-mining property with lodes in both granite and sedimentary rocks, but eluvial material has also been worked by monitors. At Kanbauk, in the valley of the Tin Ye stream on the southern flank of the Heinze basin, tin and wolfram are produced from detrital and alluvial deposits by gravel pumps and sluicing. Tin dredges operate in the Heinze basin and also in the Kyauk Medaung area. Cassiterite is also worked in alluvial beds at Heinda on Hpolontaung. This hill consists of a series of pebble and boulder beds about 200 ft. thick derived from the granite ranges to the west.

The Mawchi mines in the Karenni States (described in this BULLETIN, **38**, 1940, pp. 489-492) are the largest producers in Burma. About 64 veins are now worked and yield about equal amounts of cassiterite and wolfram. The Mawchi area was at one time well nigh inaccessible, but a road 80 miles long has now been built to Toungoo on the Rangoon-Mandalay railway in addition to the earlier road to Loikaw and Shwenyaung on the Southern Shan States Railway.

In the Yamèthin district the main producing area is around Hman-pya-taung. Numerous narrow quartz veins occur in the granite and the contiguous sedimentary rocks and carry wolfram and cassiterite. The minerals are won by both lode-mining and the sluicing of eluvial and small alluvial deposits.

Lead, Silver and other Metals from Bawdwin.—Lead, with its attendant silver, is the most important of the refined products, produced from the mixed metalliferous ores of the Bawdwin Mines of the Burma Corporation, Limited. These mines account for practically the whole of the lead-silver output of Burma. Zinc-blende also occurs in intimate association with these ores.

The deposits are enclosed in a series of ancient rhyolites and rhyolitic tuffs which form a kind of dome-shaped structure on a N.W.-S.E. strike protruding through the younger Pangyun strata.

The three main lodes strike about 25° west of north and really form one ore body, about 3,000 ft. long, which has been divided into three sections of more or less equal length by the Yunnan fault to the north and the Hsenwi fault to the south. The central section is known as the Chinaman lode; the Shan lode to the north of the Yunnan fault has been thrown 700 ft. to the north-east; the Meingtha lode to the south of the Hsenwi fault has been thrown 1,200 ft. to the south-east.

The Chinaman lode has been developed along the strike and dip for more than 1,000 ft; the width of solid ore varies up to a maximum of 140 ft., averaging perhaps 50 ft. The Shan lode has an average width of about 20 ft. and development to date on the Meingtha lode indicates a similar average width of 20 ft. The dip throughout is to the west, averaging perhaps 70°, although it

appears to be turning to the east in depth. The ore body pitches to the north.

For the most part the hanging-wall is well-defined and regular, but, to the east of the solid ore, thin parallel bands of ore occur in the mineralised tuffs of the shear channel, so that the foot-wall is ill-defined and gradually merges into barren country. These parallel branch veins join the hanging-wall solid ore in depth. Solid high-grade lead-zinc ore occurs on the well-defined hanging-wall, but the values gradually decrease towards the foot-wall where stoping is controlled by what is, at the time, considered to be payable ore; the limit is now taken at 16 per cent. combined lead and zinc with accompanying silver. The limit in depth of the Chinaman lode appears to be a bed of sediments at No. 10 level. The ore has been subjected to crushing during deposition, which is obvious both in the mine and under the microscope.

Mineralisation has been accompanied by silicification and sericitisation of the tuffs and rhyolite. Widespread chloritisation is also noticeable in the deeper levels, and adularia has been noted by Maclaren and Coggin Brown.

The ore body appears at the surface as wide zone of soft rocks stained with oxides of iron and typical copper and lead carbonates and sulphates. The oxidised zone appears to have been shallow, rarely exceeding 50 ft., below which was a narrow zone containing supergene chalcocite.

Dr. Coggin Brown was of the opinion that the mineralisation is related to an underlying granite magma—the Tawng Peng granite.

The ore reserves on June 30, 1938, are estimated at 3,766,693 tons assaying 17·7 oz. silver per ton and 23·1 per cent. Pb, 14 per cent. Zn and 0·94 per cent. Cu. A limited amount of copper occurs in the main lead-zinc lodes, and a flat dipping copper vein in rhyolite, the Chin lode, contains an average of 8·41 per cent. Cu. A copper matte is produced from these ores containing (in 1938) 42·46 per cent. Cu, 28·76 per cent. Pb and 71·61 oz. silver per ton. A nickel-cobalt speiss is also produced in smelting the Bawdwin ores, and contains 31·32 per cent. Ni, 8·60 per cent. Cu, 6·69 per cent. Co and 15·13 oz. of silver per ton. Antimony also occurs in the mixed ores and there is a regular export of antimonial lead which contains 81·76 per cent. Pb, 17·59 per cent. Sb, 0·22 per cent. Cu and 2·93 oz. of silver per ton. The iron ore required as a flux for smelting the Bawdwin ores has been produced from Twinnge, Wetwin, Kunghka, Manmaklang and Nam Phat, and Naungthakaw. A considerable number of other deposits of lead-zinc-silver ores are known in various parts of Burma, but though some of these have been exploited on a small scale in the past none are being worked at the present time.

Petroleum, Natural Gas and Oil Shale.—The central tract of Burma lying between the foothills of the Arakan Yoma on the west

and the highlands of the Shan plateau and their southern prolongations on the east is known as Pegu Gulf.

A striking feature of the geological structure of the western part of the Pegu Gulf are the two long synclinal troughs, the one of the Chindwin and the other of the Lower Irrawaddy, which separate the western monocline from a broad series of folds to the east. The main oilfields of Burma are on the first anticlines which rise to the east of these synclines, whilst on the western margin are numerous oil-shows in the western outcrops. Oil seepages are rare to the east of the folds which form the eastern boundary of the main synclines, whilst test wells on structures which do not arise directly from this syncline have found no oil in economic quantity.

Yenangyaung, the most productive oilfield of Burma, lies some 2 miles to the east of the Irrawaddy at Yenangyaung in the Magwe district. The oil-bearing strata form an almost symmetrical, elongated dome, about 6 miles long and 1 mile broad.

The Singu oilfield, in the Myingyan district, lies further north but on the same bank of the Irrawaddy as Yenangyaung ; it is really the southern prolongation of the exposure of Pegu rocks that has given rise to the Yanangyat field but the anticlinal structure is slightly *en echelon* to that of Yenangyat.

In addition to these the other oilfields of Burma are described by Clegg, together with information as to their output according to the latest data available. These include the Lanywa, Yenangyat, Indaw, Minbu and Padaukpin fields. Gas emanations and oil seepages are also known in several parts of Burma.

Deposits of oil shale occur near Kawkareik, Myawaddy and in the Mergui district, but none of these is being exploited.

Gold and Platinum.—The output of gold from Burma has declined since the liquidation of the Burma Gold Dredging Company in 1918. Gold is widely distributed throughout Burma, but it has yet to be demonstrated that any of the deposits are payable and at the new price of gold this is shortly to be investigated.

Platinum and iridosmine are associated with the gold in the alluvium of the Chindwin district, and in the auriferous sands of the Putao district, of the Uyu valley in Myitkyina and of the Irrawaddy north of Myitkyina town. Gold ore from parts of the Katha district also contain platinum and iridosmine.

Non-metallic Minerals.—Corundum is worked in the Mogok subdivision of the Katha district. In the process of extracting rubies and other gems a certain amount of " gear " or corundum of opaque colour is produced and sold as an abrasive.

Barytes occurs in association with the ores at Bawdwin, Kyawk-Htap, Thabyu and in association with quartz and calcite at Mawson. It is also known at Konlean, near hill " 5028 " and near Anisakan.

Mica in small quantities has been obtained from Yenyau, near Thabeitkyin, in the Katha district, and has also been reported from the Indaw river in Myitkyina district. That in the Katha district

occurs as books too small to be of commercial value and cannot compete with Indian mica. Larger books occur in the Myitkyina district, but the mica is always badly cleaved and strained.

Precious and Semi-Precious Stones.—Burma is famous for its gemstones, especially rubies, all of which originate from Mogok, and the main mining centres are Mogok, Kathe and Kyatpyin. Since the demise of the Burma Ruby Mines Company work has been carried on mostly by primitive methods, but recently several extraordinary licences have been granted for mining by gravel pumps.

Apatite of a peculiar blue colour is found in Mogok. Aquamarine of a sea-green and bluish-green colour is found at the Sakangyi rock crystal mines and at Mogok. Chrysoberyl is occasionally obtained from Mogok. Chrysolite (peridote or olivine) occurs in peridotite near Bernardmyo. Moonstone, garnet, iolite and lapis lazuli are also found in Mogok. Rock crystal occurs in pegmatite veins in gneiss at Sakangyi and some extraordinarily large crystals have been found but the pegmatite is not worked at present. Tourmaline is found in Karenni, Mongmit, and Mong Long. Rubies, besides being found in the Mogok area are also known to occur in the Mandalay and Myitkyina districts. Zircon of both the hyacinth and amber-coloured varieties occur in Mogok.

The amber mines of Burma are situated at Maingkwan in the Upper Chindwin district. Burmese amber is slightly harder and heavier than Baltic amber. Its colour varies from pale yellow to reddish and brown and is remarkable for its bluish-green fluorescence.

Jadeite has been worked at Tawmaw in the Myitkyina district from time immemorial.

Minerals in the Mashaba District, Southern Rhodesia.—In *Short Report No.* 34 *of the Southern Rhodesia Geological Survey*, R. Tyndale-Biscoe has reviewed the geology and principal mineral deposits of the Mashaba district, and the following abstracts have been taken from this report.

Although the area considered is principally the western part of the Victoria gold-belt, reconnaissance was also extended north and north-westwards into the Chilimanzi and Selukwe Reserves respectively.

In this area there are five producing asbestos mines, Gath's, King, Regina, D.S.O. and Murie. The asbestos at Gath's occurs in groups of roughly parallel seams of cross-fibre within a zone some 200 ft. in width and dipping northward at 35°. The fibre seams are always bordered by a zone, 1 in. to 1¼ in. wide, of bright green serpentine which contrasts strongly with the almost black, partly-serpentinized material forming the country rock between the seams. The granite contact lies only a few hundred feet to the north of the fibre zone.

The deposit has been quarried out to within 50 ft. of the second

level, and development has been carried out to the fourth level. An undulating sill of dolerite, just above the second level, cuts the fibre zone with a generally horizontal attitude.

On the north side of the main quarry the serpentine is strongly cleaved and penetrated by magnesite veins dipping at a low angle southward, i.e. opposite to the dip of the lode.

Unlike the lodes at Shabanie, the Mashaba lodes have no large mass of talc-schist on their foot-wall. On both hanging and foot-walls the fibre seams diminish gradually in numbers and size into the partly serpentinized country rocks. The average asbestos content of the rock mined is 1 per cent.

At the King mine the asbestos deposits are plum-shaped and that now being worked showed short-fibre at the surface but improved in grade with depth. The quarry floor is at the fourth level and the fibre zone, which is increasing in size with depth, has been developed to the seventh level. The seams are unusual in that they exhibit no conspicuous parallelism and generally take the form of a stockwork, though in places a dominantly westerly dip of 45° is developed. The average grade of rock mined averages 2 per cent. of asbestos.

The deposit at the Regina mine is considerably smaller than those at either Gath's or King, and consists of parallel seams dipping north-east at 40°. This occurrence is in hilly country and the cut-and-fill method of stoping adopted is consequently carried out from adits, the output, together with that from the King property, being sent to Gath's for treatment. The small deposits of asbestos at the D.S.O. and Murie properties are quarried on a small scale and the mode of occurrence at the Murie is similar to that of the Regina.

The chromite belt lies to the east of the King asbestos zone, and the chrome ore is found in isolated lenticular masses, apparently as segregations unconnected with fractures, a mode of occurrence which makes cheap mining impossible.

At the Empress mine gold is being worked in open-cuts in three distinct bodies, the west, middle and east bodies, all of which are in contorted banded-ironstone. Parts of the rock mass are only partially replaced by sulphides and quartz, but elsewhere replacement is so complete that the original banding is obliterated resulting in material consisting wholly of massive pyrrhotite and vein quartz. Until recently, however, only oxidised ore has been mined.

Other deposits of gold ores, all of which occur in banded-ironstone and which are being worked, developed or have recently been worked in this area, include the Olympus, Pelion, Ossa, Crown Lennox, Kia Ora and Mont d'Or mines. The Margrate Neilson body is exceptional in that it is a quartz and sulphide replacement of a micaceous quartz-schist along a fracture zone.

The Cambrian and Texas mines are operating gold deposits occurring in quartz veins in granitic rocks adjoining the schist belt.

Mineral Resources of the North-West Frontier Province of India.—The mineral production of the province is by no means large and consists almost entirely of salt, limestone, marble, road metal and clay. A survey of these resources has, however, recently been prepared, principally for the guidance of the Developments Department of the Government, by A. L. Coulson in *Rec. Geol. Surv. Ind.*, 1940, **75**, *Prof. Pap. No.* 2, from which the following notes have been abstracted. The annual value of the recorded mineral production of the province averages Rs. 75,000, and in 1938 was well over Rs. 80,000. The bulk of this is accounted for by the annual production of about 20,000 tons of rock-salt from Kohat, worth Rs. 60,000, and the remainder chiefly by limestone, marble and miscellaneous building and road material, of which 13,000 tons valued at Rs. 20,000 was produced in Peshawar in 1938. In addition 95 tons of marble valued at Rs. 1,000 was produced in the Khyber Agency in the same year and 31 tons of zinckenite was obtained from Chitral in 1937 and 1938.

Salt.—The salt of the Kohat district is being developed by the Northern India Salt Department. Presumably the amount produced is regulated by the Department's requirements, which are controlled by various factors entailing a consideration of the output of other Indian producers.

The rock-salt occurs in beds of great thickness, measuring in one instance at least 1,000 ft. at a single distinct horizon overlain by nummulitic limestone. The beds of rock-salt are exposed in the axis of a series of narrow, elliptical, anticlinal folds, so that the outcrop is never continuous for any great distance. The salt, which is of great purity, differs from that of the Salt Range in being greyish whereas the latter is red.

The salt occurs at Jatta, Bahadur Khel and Kark Kharak on a scale sufficient not only to supply the local demands, but to provide for export to the Trans-Frontier tract and Afghanistan. According to Gee the annual output from these three places is about 21,000 tons. At all three localities bands of clay and sand are intercalated with the salt which is worked by hand methods in a number of small quarries. The deposits near the surface are so extensive that working to any appreciable depth is unnecessary. Formerly salt was also quarried at Malgin, 13 miles east of Jatta. Gee states that there is undoubtedly sufficient outcrop salt at the above-mentioned places and at other fairly accessible localities to meet the demand for many decades merely by quarrying.

Limestone and Marble.—Limestone and marble are the chief building stones of the North-West Frontier Province. The marble of the Mullagori country in the Khyber Agency has been quarried for some years past and taken to a works at Peshawar. It is a pure white saccharoidal stone, translucent in thin slabs, and is said to be equal in appearance to the Makrana marble of Jodhpur or to Carrara marble. It has been used successfully for translucent

ornaments of various kinds and as an ornamental building stone (polished and unpolished) on a small scale in Peshawar for such purpose as flooring, fireplaces, etc. As a flooring material this white marble has been used particularly in conjunction with a black slate obtained from quarries about a mile south-west of Jhangira Road railway station.

Marble of good quality also occurs in the ridge known as Ghundai Tarako. It is finer grained than the above-mentioned stone and is more suitable for statuary.

The province is exceedingly rich in deposits of limestone of varying degrees of purity, and at several localities it is burnt for lime, e.g. at Nowshera, Ghundai Tarako, Maneri, Kohat, etc.

A considerable range of other minerals is known to occur in the North-West Frontier Province. These include, for instance, abrasives, antimony and arsenic ores, asbestos, gypsum, iron ore, lead ore, manganese ore, platinum, precious stones, etc., as well as coal and indications of petroleum, but most of these are either of academic interest only or are of low grade and have fallen into disuse. One or two examples of these, however, may be of interest.

Arsenic.—Ores of arsenic (orpiment and realgar) have long been known in the Chitral, where the mines are of considerable age. To put the older workings into order would be a long and probably expensive process and it is doubtful whether the results that might be obtained would be worth the expense entailed.

Gold.—No occurrences of reef gold in commercial quantity are known in the Province, but gold-washing has been carried on from time immemorial in Chitral, though it has been neglected during the last few years. Gold-washing is a State monopoly, and the workers perform their task in return for the small estate they enjoy, never exerting themselves to a great extent. No further cess or toll is levied on the gold. Owing to floods in summer and cold in winter gold-washing is only carried on for about five months in the year. The only tributaries of the Chitral river which carry gold are the Reshun Gol, Kuragh Gol and Roman Gol, all of which rise in the Phargam mountain. According to C. S. Middlemiss, gold is washed from the gravels of the Indus river above Lalogali, near Kirpalian. It is interesting to note that in his classic book on gold, Maclaren states that above Attock, and in the upper waters of the Indus, and in the Alakananda, small gravel banks were worked in 1908. Much of this gold, he states, is probably derived from the Tibetan plateau, since many of the Indo-Gangetic streams have pushed their way through the main range and captured some of the drainage channels of that region. Some of the islands (*belas*) in the Indus, which are worked from time to time by the indigenous gold-washers, are partly in the Hazara district and partly in the Mardan district. Gold-washing is carried on during the rains in the Teri Toi near Banda Zartangi village, the practice being responsible

for the name of the village, but the source of the gold is unknown. A number of other minor gold occurrences are also known.

Iron.—Large quantities of magnetic iron sand are reported to occur in the valley of the Panjkora river, especially in Baraul and in the Laspur Jandawal hills. The iron is exported to Kabul, where it is said to be greatly esteemed. Earthy haematite is said to occur in abundance among the hills to the south-east of Bannu. The metal is worked up at Kalabagh into nails, cooking utensils, etc. Tipper noted abundant haematite in the quartzites of the Chitral slate series, halfway between Sanoghar and Mastey on the bank of the river, but without fuel, and at such a distance from any large centre, the iron ores can have little value except for local use. Occurrences of earthy haematite and manganiferous limonite have been noted in several localities.

The manufacture of iron by primitive native methods is carried out at Kaniguram and Makin.

Lead and Antimony.—Jamesonite, a sulphantimonite of lead, occurs at a locality 5 miles south of Awi. Attempts have been made to utilise the mineral locally as a source of lead, but without any great success. Unfortunately, unless there is a considerable percentage of silver in the ore, jamesonite is not used as a source of antimony.

Zinckenite, another lead sulphantimonite, has recently been mined and exported from Chitral. The mineral is supposed to occur at Shaghor and the mining lease is held by a Mr. Parekh. No further details of the occurrence are available.

Mica and Beryl.—The Geological Survey of India were recently informed that an application had been made for a lease to mine mica and beryl from a small area near Giddarpur in the Hazara district. Details of the occurrence are not known but there is no reason why workable deposits of mica should not be found in the pegmatites accompanying the Hazara granite, though none have hitherto been met with.

Cement.—Portland cement is made by the Punjab Portland Cement Co., Ltd., at the eastern termination of the Hasan Abdul hill, in the village area of Wah. The raw materials used are Laki limestone from the Hasan Abdul hill, alluvial clay, which is dug up close to the works, and gypsum, which comes from Khewra in the Salt Range.

Water Power.—Not the least important of the natural resources of the province is its water power, and the Malakand hydro-electric scheme has now been in use for some years.

Economic Minerals in the Philippines.—Prior to 1907 the mineral production of the Philippine Islands was so small that it was not considered worth recording in the statistical returns of the country; it was, in fact, less than 1 per cent. of the value of the present output. In 1938, however, the value of the mineral production of

the country was over 75 million pesos (2 pesos = $1 U.S.), and the mineral industry now takes second place only to sugar in the prime industries of the islands. Whilst this is due in large measure to the increased output and price of gold, equally noteworthy is the substantial increase in the value of base metal and non-metallic minerals in recent years as shown in the table on p. 183.

Particularly outstanding in the mineral industry of the Philippines is the fact that they now produce not inconsiderable quantities of manganese and chrome ore, both of which are deficiency minerals in the United States. A comprehensive and detailed review of the mineral deposits of the Commonwealth has recently been published as *Technical Bulletin* 13, *Philippine Department of Agriculture and Commerce*, which deals with the mineral resources of the Philippines for the years 1934-1938, part I being on gold mines and part II on base metals and non-metallic minerals.

Gold.—The gold production of the Philippines has increased from 160,620 oz. in 1929 to 919,263 oz. in 1938, a growth which is even more remarkable when considered on the basis of value; 6,640,600 pesos in 1929 and 64,348,413 pesos in 1938. Before 1933 more than 95 per cent. of the gold production of the islands originated in the Baguio area of Mountain Province, but at the present time the Paracale, Masbate and Surigao Provinces are also important contributors and altogether more than 20 mines with daily mill-capacities ranging from 80 to 3,000 tons are now in operation with others coming into production. Of these the San Mauricio mine in the Paracale field, which is working an ore averaging nearly ½ oz. per ton, is the richest lode being exploited. In addition, four alluvial properties are being operated in the Islands, one of which, the well-known Coco-Grove, being among the largest dredging operations known.

Although the production of gold in the Philippines completely overshadows in value that of all other minerals put together, the output of base metals and non-metallic minerals, particularly iron ore, copper, chromite and manganese has also made considerable progress in recent years, having increased in value to 11,271,451 pesos in 1938, from 1,479,572 pesos in 1934, representing 15 per cent. (against 6 per cent.) of the value of the total mineral production of the country.

Iron Ore.—Iron ore production is rapidly reaching the level of one million metric tons annually, but as there is no domestic iron and steel industry in the Islands, the output of iron ore has been exclusively marketed in Japan. The value of the iron ore output constitutes over a third of that of all minerals, other than gold, produced in the country.

Copper.—Copper is known to occur in many parts of the Philippine Islands, but with the exception of the Lepanto deposit, which has been worked intermittently for centuries, systematic mining for ores of this metal commenced only in 1937, since when the entire

MINERAL PRODUCTION OF THE PHILIPPINES

(Base metal figures are shipments as reported by the Bureau of Customs)

		Quinquennial Total 1934–1938.	1934.	1935.	1936.	1937.	1938.
Gold . . .	*oz.*	3,036,135·43	340,313·13	495,701·09	599,453·00	703,580·00	897,088·21
	pesos	209,268,145·00	23,823,365·00	31,602,266·00	41,961,710·00	49,250,600·00	62,630,204·09
Silver . . .	*oz.*	3,009,369·32	212,610·15	353,305·78	494,744·04	773,517·01	1,175,192·34
	pesos	4,038,056·52	272,060·00	475,921·00	766,448·30	1,036,471·95	1,487,155·27
Chromite . . .	*kilos*	149,949,136·00	—	1,292,059·00	11,890,602·00	69,855,606·00	66,910,869·00
	pesos	3,454,021·00	—	27,558·00	307,518·00	1,542,100·00	1,576,845·00
Copper . . .	*kilos**	—	—	115,431·00	6,054·00	15,413,540·00	26,571,309·00
	pesos	2,784,103·00	—	126,167·00	1,704·00	656,451·00	1,999,781·00
Iron . . .	*kilos*	2,450,145,975·00	239,344·00	283,310,214·00	654,455,921·00	601,188,220·00	910,952,276·00
	pesos	10,774,428·00	29,349·00	1,143,929·00	2,868,427·00	2,652,078·00	4,080,645·00
Lead . . .	*kilos†*	—	—	—	—	—	216,447·00
	pesos	61,586·00	—	—	—	49,975·00	11,611·00
Manganese . .	*kilos*	62,339,709·00	—	519,310·00	254,972·00	12,206,278·00	49,359,149·00
	pesos	1,355,856·00	—	13,213·00	6,020·00	337,716·00	998,907·00
Value of ore production	*pesos*	231,736,195·61	24,124,774·00	33,389,054·00	45,911,827·30	55,525,391·95	72,785,148·36
Value of non-metallic production‡	*pesos*	9,244,523·97	1,450,223·25	1,575,996·34	1,619,746·48	1,994,896·01	2,603,661·89
Total value	*pesos*	240,980,719·58	25,574,997·25	34,965,050·34	47,531,573·78	57,520,287·96	75,388,810·25

* *Includes copper ore, bullion, matte and concentrates.*

† *Includes lead ore and lead bullion.*

‡ *Includes sand, gravel, crushed rock, clay products, bricks, earthenware, lime rock, building stones, ornamental stones, guano, salts, mineral water, and volcanic ash.*

output has been consigned to Japan, largely owing to freight considerations. The recent construction of a smelter at Lepanto will, however, lead to the exporting of blister copper or high-grade copper matte to the States, it is believed. A certain amount of copper is also produced in the smelting of the flotation concentrates from properties which are worked principally for gold.

Chromite.—Although some of the chromite deposits of the Philippines are comparatively low-grade, they are important in view of the large reserves available. These deposits, together with others of higher-grade ore, are also significant because they are the principal source of supply of this mineral under American control. The United States took 86 per cent. of the 1935-1938 chromite output, but as with Philippine copper concentrates, freight space and rates are ever-attendant problems.

Manganese.—Another mineral commodity on the United States strategic list and which can be partly supplied by the Philippines is manganese, exports of which formerly went to Japan, again largely because of problems of transport. Deposits of manganese are fairly widespread throughout the Philippines, but with few exceptions, they are individually small occurrences. The deposits on Busuanga Island average about 50 per cent., whilst those in other parts which are of the order of 40 per cent. can, it is claimed, be readily beneficiated.

Coal.—Coal mining had been virtually dormant in the Philippines for a number of years prior to 1939, but a survey of the coal resources of the islands, commenced in 1937, assumed increased importance with the rise in prices since the outbreak of the present war. The coal is used for the local production of power, in the manufacture of cement and producer gas, and for railway and steamer fuel.

Other minerals and rocks produced in the Philippines include petroleum, clays, building and road stones, cement-making materials, etc.

Artificial Optical Crystals.—Naturally-occurring crystalline minerals used in optics, in ultra-violet and infra-red spectroscopy, include calcite, quartz, fluorspar, rock salt and sylvite, but the quantities, qualities and sizes of such crystals available are very restricted, and considerable interest therefore attaches to the experiments which have been carried out in recent years with a view to synthesising crystals which possess the requisite properties of transmission and dispersion. These synthetic crystals and the technique of their growth by the continuous crystallisation of suitable molten salts have recently been reviewed by H. C. Kremers in an article in *Ind. and Engng. Chem., Ind. Ed.*, 1940, **32** (11), 1478-1482, from which the following notes have been taken. Lithium fluoride, sodium chloride, potassium bromide, potassium iodide and sodium nitrate are the most important of such artificially-grown crystals.

The present technique used is a development by Stockbarger of the Bridgman method of lowering a platinum crucible containing the molten salt through the core of an annular tube furnace. The modification by Stockbarger consists in the employment of two annular tube furnaces separated by a close-fitting metal diaphragm. The upper furnace is held above the melting point of the salt but not high enough to cause excessive vaporisation. The lower furnace temperature is adjusted sufficiently below the melting point of the salt so that when the crucible is lowered through the diaphragm freezing or crystallisation takes place in the region of high gradient between the two furnaces. The method thus constitutes a so-called continuous crystallisation process, the rate being determined by the speed of lowering the crucible.

After crystallisation is complete the crystal is removed from the crucible by inverting it and quickly heating until the contents drop out. The crystal is then annealed for 7 to 10 days at a temperature about 50° C. below its melting point.

Theoretically, crystals up to any diameter can be grown by this method. Actually crystals 8 in. (20·3 cm.) are being produced, and it is probable that 10 or 12 in. (25·4 or 30·5 cm.) constitutes the practical limit. Up to 10 days are required to grow a crystal, and during this period all mechanical operations, such as lowering of the crystal, temperature control, variation in gradient, etc., must be under absolute manual and automatic control. The temperatures of the crystallising furnaces vary by not more than 0·1° C.

Lithium Fluoride.—Since ultra-violet transmission is a function of low molecular weight, all heavy metal impurities must be carefully removed from the salt before the crystals are made. Single crystals of lithium fluoride up to 4,000 grams in weight are not difficult to grow. Owing to the extremely high heat of fusion of this salt the crystallisation rate can easily be controlled, but lithium fluoride must be grown under an extremely high gradient to effect the necessary additional purification during growth.

Optical lithium fluoride can satisfactorily be substituted for fluorspar for ultra-violet spectroscopy. The changes in transmission due to irradiation with ultra-violet light are about the same as those experienced with fluorspar. The low index of refraction and the low dispersion of lithium fluoride over the visible and near-ultra-violet range, make it an excellent component for achromatic lens combinations, especially in conjunction with quartz.

Rock Salt.—As rock salt shows excellent dispersion over its entire transmission range, it has long been a favourite for infra-red spectroscopy. It has been difficult, however, to obtain natural rock salt crystals of sufficient size and quality for the purpose, particularly as the Russian supply has been entirely cut off for the last few years.

Synthetic sodium chloride crystals up to 25 lb. (11·3 kg.) in weight can be made, and from these 60° prisms, 4 to 5 in. (10·2 to 12·7 cm.) tall with 6 in. (15·2 cm.) faces are now cut. They are

probably the largest rock salt prisms ever made, their quality is superior to that of natural rock salt, and the availability of these exceptionally large prisms has facilitated the design and construction of infra-red spectrographs, previously considered impossible.

Potassium Bromide and Iodide.—Potassium bromide has optical characteristics similar to those of rock salt, but having a higher molecular weight, it transmits farther into the infra-red. Crystals weighing up to 25 lb. are produced, but they are considerably more difficult to grow than either rock salt or lithium fluoride.

Because of its high molecular weight, potassium iodide will transmit to about 40 microns; it can be grown under conditions similar to potassium bromide.

Sodium Nitrate.—The acute shortage of calcite in the larger sizes has for several years stimulated the search for a substitute, and sodium nitrate, which crystallises in the same system as calcite, has long been known to have possibilities in this direction. Single crystals weighing up to 25 lb. can now be produced by the method outlined above from the molten salt.

Large sodium nitrate crystals are most difficult to produce because owing to its low melting point (308° C.) high gradients cannot be maintained, and also material crystallising in any other than the isometric system tends to grow faster in certain directions than in others. In the case of sodium nitrate (trigonal system) crystallisation is most rapid in the direction of the optic axis.

As will be seen from the following table of refractive indices sodium nitrate has a higher birefringence than calcite.

Wave Length.	Sodium Nitrate.		Calcite.	
λ	ω	ϵ	ω	ϵ
434	1·6126	1·340	1·67552	1·49428
501	1·5968	1·337	1·66604	1·48992
589	1·5848	1·336	1·65836	1·48641
668	1·5783	1·334	1·65381	1·48436

Cutting and Polishing.—The cutting and polishing of lithium fluoride for optical purposes presents no unusual problems, but water-soluble crystals are cut with a wet endless string.

As the uses of these crystals in special fields of optics become better known, it is expected that many other types will be developed.

Blast Furnace Slag Aggregates.—An investigation into the uses of blast furnace slag in building construction which has been in progress at the Building Research Station is described in an article by T. W. Parker in *Chem. and Ind.*, 1941, **60**, 5.

The major components of blast furnace slag are CaO, MgO, SiO_2 and Al_2O_3, the ratio of these varying according to the raw materials, the furnace burden and the grade of iron being made. Most of the slag used in this country for heavy aggregates may be regarded as being composed chiefly of a melilite with one or more

calcium silicates or anorthite and minor constituents. It has been found that the phenomenon known as " falling " (the disintegration and powdering of the slag on cooling) is caused by the crystalline inversion of the compound $2CaO \cdot SiO_2$.

Slag suitable for use in heavy aggregates must be a stable, dense, solid product with a suitable stony texture, and attempts which have been made to adjust these requirements include the alteration of the slag composition in the furnace and the treatment of the molten slag after leaving it. The degree to which the composition of the slag can be adjusted is of course limited, but the lime content is kept as low as possible to avoid falling.

After tapping, the slag may be treated by the addition of sand or flue dust, etc., to release any trapped gases, while the addition of the former also tends to reduce falling. Stability and texture are affected by the method and rate of cooling, and the pouring of molten slag may cause air to be trapped in it, while the volatilisation of moisture in the receptacles also tends to produce an undesirable honeycomb texture, which reduces the powder density below the optimum of about 3·0. A test of the density of the graded aggregate can be used to determine the extent of honeycombing and is a method of sorting out slags suitable for heavy aggregates.

Acid slags cool more quickly than basic ones, and tend to become glassy whereas the latter tend to become too crystalline. Glassy slags are brittle and coarse slags used in slag-macadam manufacture crush more readily under traffic. In concrete aggregate glassy material probably gives a poorer bond with the binder than crystalline slag. Quick cooling, however, inclines to prevent falling as the $2CaO \cdot SiO_2$ is retained in the glass.

There are three general methods of cooling. From the furnace the slag is poured into ladles, the capacity of which at various works ranges from 2 to 15 tons with an average of 5 to 7 tons, and the sand or flue dust is then added if necessary. If the slag is suitable for slow cooling it is left to solidify in the ladle and then tipped out as a solid casting or slag " ball " in the stockyard where it is left for 14 days. If there is no falling after this period the slag is regarded as stable. This method is probably the most widely used and gives the densest product. In the second method the slag is poured into pits or canals, the most suitable size and depth of these for a particular slag being determined by trial. Two or three layers are usually poured and each layer tends to anneal the one beneath it. The slag is excavated as soon as it is sufficiently cool; for tar-macadam manufacture it may be removed while it is still warm to avoid the necessity of drying. There is a risk of honeycombing during pouring or if the pits are wet, but the advantage of the method lies in the stabilising effect of rapid cooling and the avoidance of the necessity for a large number of ladles. In the third method the slag is poured slowly and carefully on a bank. A further source of supply of slag is from old slag banks.

After cooling the processing operation is simple. In the " ball " method any falling balls are rejected on inspection after the storage period. The remainder are broken up manually or mechanically and are sometimes hand picked to remove honeycombed and glassy pieces. The material then passes to jaw crushers and thence to screens either direct or over a magnetic separator. Pit slag and bank slag are excavated mechanically, crushed, screened and passed to storage. Bank slags usually need drying.

In 1936 the estimated output of slag in this country was 6¾ million tons and of this, it is estimated, 2½ million tons were used for road making. Tar-macadam base courses containing slag have been used on all classes of roads with success. Tar-macadam toppings have been used chiefly on residential and secondary roads with varying success which is attributed to the difference in care taken in selecting the slag at the works. Bitumen toppings have been satisfactorily used on main roads, as have slag pitchings on residential roads. From observations made on the use of slag in concrete, it was deduced that slag concretes appear to be slower in early hardening than gravel concretes while it has been found in practice to be an advantage to substitute sand for the fine slag, particularly in mass concrete. In general, however, slag concrete compared favourably with gravel concrete provided the sulphate and sulphur content were reasonably low, and in fire resistance it had advantages.

China Glass in India.—The manufacture of china glass, an opaque white or coloured glass used particularly for the decoration of glass bangles, is an important item in the Indian bangle industry. As many of the raw materials for this industry are normally imported into India at fairly high prices, an investigation has been made into the possibility of manufacturing such opaque glasses in India at a reasonable cost. The results of this investigation are contained in an article by Atma Ram and Lal C. Verman, *Bull. Indian Indus. Res. No.* 17, 1940, Delhi, from which the following account has been abstracted.

Among the well-known glass opacifiers some cannot be used owing to cost (as for example ZrO_2) or because of Indian prejudice (e.g. bone ash), whilst others are unsuitable for use with lead glasses, which are preferable to borosilicate or high-alkali glasses for the manufacture of bangles.

The sand used in these investigations was the Barhgarh sand of grain size between 50 and 100 B.S.S., and of the following chemical composition :

SiO_2.	Fe_2O_3.	Al_2O_3.	TiO_2.	CaO.	MgO.	K_2O+Na_2O.	Loss.	Total.
97·10	0·03	1·09	0·12	tr.	0·16	0·80	0·62	99·92

The glass batches of about 100 gms. each were heated in small fireclay crucibles at about 900° C. for one hour in a gas-fired laboratory

furnace, after which the temperature was slowly raised to 1,200° C., at which it was maintained for 2 hours, then lowered to 1,000° C. for an hour, after which the molten glass was poured out in the form of discs and allowed to cool slowly in a muffle furnace. For the development of maximum opacity the arsenious oxide glasses had to be cooled gradually, whereas the other batches did not require particularly slow cooling.

Each glass sample was then finely powdered, converted into a thick paste with water and applied in the shape of dots to a transparent colourless glass slide. After drying, the slides were gradually heated in a muffle furnace to about 650° C., at which they were kept for 5 to 7 minutes and finally slowly cooled. The resulting enamel was subsequently examined visually and tested for adhesion by scratching with a knife.

The loss of arsenious oxide due to its volatility was found to be about 20 per cent., whilst the amount of fluorine finally present in the glass was found to be negligible. It is very likely that the fluorine originally present in the batch was lost as a result of the formation of silicon tetrafluoride, which is volatile. The addition of a small quantity (1 per cent.) of cryolite appeared to improve the whiteness of the product.

From an examination of the results of these experiments the following conclusions may be drawn with regard to the preparation of white opaque glasses:

1. Felspars produced a more dense opaque glass than either kaolin or pure alumina, although the aluminium oxide content might be the same in all cases.
2. The addition of titanium oxide in small amounts seemed to improve both opacity and whiteness, but it should be used in very small proportions since its presence in larger amounts raises the melting point of the resulting glass.
3. The presence of small amounts of antimony oxide appeared to improve the gloss of the enamelled design to an appreciable extent.
4. Opal glasses containing cryolite as the major opacifying agent did not appear to be very suitable for use as decorative enamels for glassware.

From the results of practical tests it was evident that one of these experimental glasses at least compared favourably with the comparison sample of imported china glass and could be successfully used as a decorative enamel. The composition of the batch was as follows: sand 30, red lead 50, soda ash 7·8, felspar 12·5, lime 1·5, arsenious oxide 4·0, titanium oxide 0·7, cryolite 1·0, antimony oxide 0·1, parts by weight. It appeared that arsenious oxide was a better opacifying agent than cryolite, so far as opacity and whiteness of the film on the decorated glass article were concerned. It may be possible that arsenious oxide improves the whiteness of these glasses by virtue of its decolorising action.

It may be pointed out that in India arsenious oxide is cheaper than either cryolite or tin oxide. Also, the amount of arsenious oxide to bring about the same degree of opacity is smaller than that of either of the two above-mentioned substances. It is, therefore, specially suited for use as an opacifying agent for the preparation of cheap white enamels containing a high percentage of lead oxide.

In order to investigate the industrial possibilities of these experiments, a factory-scale batch of the above composition was prepared, melted in an 800 lb. pot of a so-called Japanese type glass furnace of the kind commonly used in India, and tested. The melt was stirred several times by means of an iron rod to ensure complete homogeneity, and when the glass had become practically free from bubbles, which stage was usually reached about 4 or 5 hours from the start, the temperature was gradually lowered to about 1,000° C., and the glass was then ladled out on to a thick iron sheet to form thick discs about 6 to 8 in. in diameter.

The discs were cooled under the different conditions, but on examining and comparing the products thus obtained no significant differences were observed in their opacities. They were all found to compare favourably with the imported china glass in their decorative qualities, such as whiteness, gloss, opacity, adhesion and melting point.

The results showed that it is advisable that the discs be cooled gradually in a lehr such as is commonly used for annealing other glassware.

In addition to the above experiments, the economic aspects of manufacturing china glass in India were examined in some detail.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE TECHNOLOGY OF MAGNESIUM AND ITS ALLOYS. A Translation from the German by the Technical Staffs of F. A. Hughes & Co., Ltd., and Magnesium Elektron, Ltd., of MAGNESIUM UND SEINE LEGIERUNGEN, compiled by Dr. -Ing. E. h. Adolf Beck. Pp. xxii + 512, 9 × 6. (London: F. A. Hughes & Co., Ltd., 1940.) Price 30*s*.

This work, despite its political bias, is undoubtedly the most comprehensive and up to date that has hitherto been published on the technology of magnesium and its alloys. It represents the detailed researches of 18 experts attached to the pioneer firm of magnesium production—the I.G. Farbenindustrie A.G. of Bitterfeld, Germany—Dr. Adolf Beck, supported by Dr. Nachtigall, being responsible for the co-ordination of these researches and for the stringent editorial examination of the authors' manuscripts. Much of the information given is new and forms a notable contribution to

the scientific background of the magnesium industry generally. The English translation, now under review, is largely the work of Mr. L. H. Tripp, who by means of explanatory and critical footnotes has produced a treatise perhaps even more valuable than the original.

From a general point of view the work may be divided into 8 sections, comprising 19 chapters in all, the sections, however, being of greatly disproportionate lengths. The first contains only 17 pages and deals essentially with the industrial raw materials from which magnesium is obtained and the various thermal and electrolytic methods for its production. Next follows the largest section, comprising 255 pages, and devoted to the physical properties of magnesium single crystals, the metallography of magnesium and its alloys, together with detailed accounts of their physical and mechanical characteristics.

The third section is represented by Chapter VI (40 pp.), which discusses the chemical behaviour, corrosion and surface protection of magnesium and its alloys. Here it is shown that manganese is the most important metal from the point of view of improving their corrosion-resistance, its influence being due, on the one hand, to its refining effect, and on the other to the formation of a protective film. Although early investigations indicated that beryllium could not be alloyed with magnesium, it is now demonstrated that small amounts of the former (0·005 to 0·01 per cent.) protect liquid magnesium against oxidation to an extraordinary degree, besides decreasing the tendency to burn when magnesium alloys are cast in green sand moulds. Simultaneously, however, these small additions of beryllium lead to a substantial coarsening of grain-size, with consequent reduction of the mechanical properties of the alloy. Additions of cerium to magnesium alloys are specially interesting owing to their beneficial effect on strength at elevated temperatures; although cerium reduces corrosion-resistance only slightly, its use as an alloying constituent bears promise.

Section 4 embraces Chapters 7-14 (139 pp.) and deals primarily with the working and fabrication of magnesium alloys. Melting and casting with special reference to sand-casting are discussed at length, as also are the techniques of die-casting, pressure die-casting, extrusion, forging, rolling, and machining. The section ends by an interesting account (28 pp.) of the principles of design that should be employed for a given magnesium alloy, and further discusses correct workshop practice.

The remaining four sections are comparatively short, though much valuable information is nevertheless presented. Section 5 (26 pp.) deals with magnesium as an alloying element and also with its application in pyrotechnics and thermo-chemistry. Section 6 (4 pp.) discusses the economic importance of magnesium and contains the following estimates of metal production at the beginning of 1939: Germany, 20,000 tons per year; England, 5,000; France,

2,500; Japan, 1,000; Russia, 500; Switzerland, 500; U.S.A., 2,500. The seventh section (8 pp.) is devoted entirely to the chemical analysis of magnesium and its alloys, whilst the eighth and final section (7 pp.) is a summary of the patent specifications covering the production, fabrication and utilisation of magnesium and magnesium alloys in the United Kingdom, Austria, France, Germany, Norway, Switzerland, and the United States. More than 1,500 patent specifications have been enumerated, 300 of which refer to the United Kingdom, and of these the translators have supplied 100.

The work is excellently presented and contains in addition to name and subject indexes some 524 figures and 79 tables. Mr. Tripp, together with his co-translators, are to be congratulated upon their handling of the German original, which has resulted in an English text at once lucid and with almost no signs of being a translation.

Canadian Mines Handbook, 1941. Pp. 232, $7\frac{1}{2} \times 5\frac{1}{4}$. (Toronto: Northern Miner Press, Ltd.) Price $1·00.

The current edition of this familar annual work of reference covering the active mining companies operating or incorporated in Canada, as well as those dormant or recently defunct, closely follows the format adopted in the previous editions.

The scope of the information given regarding such companies includes the location of both the registered offices and of the property, the names of the principal officers of the company, brief notes on the types of property and the nature of the development or operations undertaken, together with data on such subjects as capitalisation, date of incorporation, ownership and recent dividend history.

In the case of the more important Canadian mining companies the above information is supplemented with details of tonnages milled, recovery, costs, etc., as well as the most recent balance sheet of the company and the latest figures available relating to the ore reserve position.

The Handbook is divided into two parts. Part I contains in alphabetical order the principal Canadian mines actually producing, or actively developing as well as a number on which sufficient work has been done recently for them to be considered to be on the active list. In this section are also to be found details of concerns like Bulolo Gold Dredging, Ltd., which, although chartered in Canada, operate a property situated abroad.

Part II largely comprises a list of the names of Canadian mining companies which are inactive or defunct at the present time. In some cases very brief information is given regarding these concerns, but where such data is lacking, reference can be made to earlier editions of the Handbook. In addition Part II also includes supplementary information concerning certain active companies which was received too late for inclusion in the relevant section of Part I.

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EXHIBITION GALLERIES, FILM LIBRARY AND CINEMA

REPORT ON IMPERIAL INSTITUTE SCHEME FOR EMPIRE LECTURES TO SCHOOLS

One of the functions of the Imperial Institute in terms of the Imperial Institute Act of 1925 is "to promote the educational interests of the British Empire," and, later in the same Act, this general instruction is more closely defined as information and instruction regarding "the resources and development of the Empire and its scenery, life and progress."

Prior to the outbreak of war the Institute had carried out these functions by means of its Exhibition Galleries and Empire Film Library, its Empire postcards and school specimens and its collection of lantern slides of the Empire. In addition, it had organised each year between October and May weekly lectures on the Overseas Empire given by lecturers—many of them post-graduate students of the Institute of Education—who had personal experience of the subjects and countries on which they lectured.

When war broke out and the Galleries and Cinema had to be closed it was no longer possible to invite school parties to attend lectures in the Cinema, and instead a scheme was prepared in co-operation with the Ministry of Information and with the approval of the Department of Overseas Trade (the Department in statutory control of the policy and activities of the Institute) whereby lecturers would be sent out to lecture to schools throughout the United Kingdom.

This scheme naturally required a good deal of preliminary organisation. It was necessary in the interests of economy to keep the expenditure as low as possible and to spend as little as might be necessary on rail journeys. The first step, therefore, was to form a panel of lecturers each of whom must have had personal experience of one or more countries of the Overseas Empire and must also be accustomed to talk to school children. With the help of the High Commissioners, the Colonial Office, the Royal Empire Society, the Victoria League and the Overseas League it was possible to build up a panel of lecturers with homes in the provinces as well as those with homes in London, but willing to lecture to provincial schools near London. London was not, however, included in the scheme

as London children had been evacuated and all the schools to be served were in the provinces, chiefly in the reception areas.

Whilst building up this panel of lecturers it was necessary to try out those whose lecturing experience and attainments were not already known, and for this purpose arrangements were made with two experienced head teachers of secondary schools within easy reach of London to try out doubtful candidates for the panel. Very helpful reports were received from both head teachers and it was possible by this means to narrow down the panel to lecturers of the standing and experience desired.

Meanwhile, with the assistance of the Board of Education, contact was made with educational authorities throughout the country controlling schools near which lecturers were domiciled. The response from these educational authorities was encouraging and a start was made with the scheme towards the middle of June 1940 with schools in Liverpool, Manchester, Birmingham, Leicester, Surrey and Middlesex. It should be understood, of course, that the beginning of the scheme was on quite small lines, and that alterations had to be made from time to time as lecturers dropped out or new lecturers became available and to meet the varying requirements of the schools. Some schools, for example, preferred lectures on General Empire subjects; others on particular countries of the Empire; some schools had film projectors, others magic lanterns; whilst other schools had neither. The demands for films and slides to accompany the lectures were met from the Imperial Institute Libraries of Empire Films and Lantern Slides, but some lecturers preferred simply a blackboard or a map as a background.

During the two and a half months, mid-June to the end of August 1940, the results were as follows:

Month.	No. of lectures given.	Aggregate of audiences.	Cost.
June (latter half) .	14	1,444	£25
July	47	7,775	£62
August . . .	22	3,100	£34

August was the "off" season for lectures. During these months opportunities were taken to revise and extend the panel of lecturers, whose number rose in July to 43; *pari passu* the scope of the scheme was extended as new lecturers, resident in more distant areas, joined the panel, and more education authorities received particulars of the scheme and agreed to invite their schools to co-operate.

During the next four months the figures were:

Month.	No. of lectures given.	Aggregate of audiences.	Cost.
September . . .	40	7,470	£66
October . . .	24	3,902	£37
November . . .	48	7,960	£90
December . . .	21	3,120	£30

By the end of September the number of lectures was 89, and by November the following additional education authorities had agreed

to join the scheme: Westmorland, Cheshire, Shropshire, Herefordshire, Warwickshire, Dorset, Devonshire, Coventry, Nottingham and Gloucester. December was again an "off" month.

In January it was decided, with much regret, after consultation with the Ministry of Information and with the Department of Overseas Trade, that the scheme should be terminated at the end of March. Although the organisation had stood up successfully to all tests and had earned many letters of keen appreciation from schools throughout the country, rural and urban alike, it was felt that funds could no longer be found for an effort which, whilst valuable during the post-evacuation period, could not be justified as a war effort when schools had settled down in the reception areas. Nevertheless, it is to be hoped that funds may be made available from private sources to resume even during war-time a scheme which is admitted on all sides to have attained astonishing success in telling to the rising generation of this country the story of the British Empire, its origin and history, its achievements, its economic activities and those principles for which it stands; and that, when peace returns, official funds may be made available from Empire sources to continue the lecture scheme.

During the three months before the scheme was brought to a conclusion, January-March 1941, the panel numbered over 100 lecturers and the scheme was extended to schools in Essex, Wiltshire, Sussex, Burnley, Exeter and Southampton. The following results were obtained:

Month.	No. of lectures given.	Aggregate of audiences.	Cost.
January . . .	17	2,680	£24
February . . .	92	12,777	£146
March . . .	72	9,040	£72

Thus during the 9½ months of its currency the scheme resulted in 397 lectures on the Empire being given to audiences aggregating over 59,000 school children at a cost of less than £600.

Requests for Empire lectures were received from about 250 different head teachers whilst the scheme was in operation. Each head teacher has been informed of the termination of the scheme and, up to date, approximately 100 head teachers have replied asking that their schools may be included in any future revival of the scheme. Such replies reach the Institute daily and it may safely be anticipated that the great majority of the schools which have had experience of the scheme will desire to resume the lectures whenever possible.

The following practical conclusions emerge:

(*a*) It is, of course, impossible for the organisers to judge the merits of lecturer-candidates on interviews alone, and it is invaluable to have the reports of one or two "examining"

teachers willing to try out candidates by means of test lectures to their classes on subjects offered by the lecturers themselves. By this means unpromising candidates are refused admission to the panel and a great deal of time, labour and friction is saved.

(b) Even after the lecturers have been carefully selected and enrolled on the panel it is essential to the success of the scheme that the head teachers be invited to furnish confidential reports on the capacity of the lecturer after each lecture is given. In every case a single adverse report was accepted as sufficient to disqualify a lecturer and to justify the removal of his name from the panel.

(c) The facilities of the Libraries of Empire Films and Empire Lantern Slides at the Imperial Institute were very much appreciated by the lecturers. In fact, during a typical month, September 1940, when 40 lectures were given, 24 were accompanied by Institute slides, 5 by Institute films, 2 by both slides and films and only 9 were " straight " talks, unaccompanied by either slides or films.

(d) After the education authorities have sounded the schools in their areas and reported the names and addresses of the head teachers prepared to apply for lectures, correspondence is best conducted direct between the head teachers and the Institute.

(e) Once the lecturers are selected and the lists of subjects known on which they are respectively competent to lecture it is wisest to leave the head teachers to choose for themselves the subjects they prefer, usually with an eye to the school lessons for the term.

(f) Although the scheme was at the outset intended for both primary and secondary schools it was found that the results were on the whole better with secondary than with primary schools.

Appendices to this report include a list of the educational authorities who co-operated with the Imperial Institute in the scheme[1] ; a list of the lecturers on the panel as finally constituted[1] ; and a list of the areas covered, or to be covered, by the scheme. The list of areas includes also the number of lecturers available in each area and the range of Empire subjects offered.

H. A. F. LINDSAY,
Director.

Imperial Institute,
April 29, 1941.

[1] Not printed.

IMPERIAL INSTITUTE SCHEME FOR EMPIRE LECTURES TO SCHOOLS.
REGIONAL ARRANGEMENTS

Region.	Counties.	No. of Lecturers available.	Subjects.
1	Northumberland Durham Yorkshire— North Riding	2	Canada; South Africa; East Africa; West Africa; India.
2	Yorkshire— West Riding East Riding	1	Malaya—Mining and Agriculture.
3	Nottinghamshire Lincolnshire Leicestershire Rutlandshire Northamptonshire Derbyshire	3	Canada; Australia; Australia—The Bush, Sheep Farming, Wheat Belt, Broken Hill; South Africa; Nigeria.
4	Norfolk Suffolk Huntingdonshire Cambridgeshire Bedfordshire Essex Hertfordshire	6	Canada; Agricultural Life in Western Canada; New Zealand; The Peoples of the Union of South Africa; Newfoundland; India; West Indies; Bahamas; West African Colonies; Tropical Crops and Products; The English Speaking Peoples.
5	London Middlesex	32	General Empire; Sea Power and the Empire; Trade Routes of the Empire; Forestry and Timbers of the Empire; The Imperial Idea; The Dominions; Our Colonial Empire; Spices and Fresh Fruits of the Colonies; Whaling on the Antarctic Fringe of the Empire; Eastern Countries under the British Flag; Canada; Australia; Australia—Climate, etc., in New South Wales; New Zealand; New Zealand (History); New Zealand (The Maoris); South Africa; Newfoundland; India; The Land of India; School Days in India; Stories from Indian History: (*a*) A Rajput Story, (*b*) Akbar's Adventure, (*c*) The Story of Clive, (*d*) Indians in the First Great War; Health and Wealth for India: (*a*) What the Government has done, (*b*) What the Missions have done; Women of India; How India is becoming a Nation; Burma; Burma—Trade and Travel; Ceylon; The West Indies—Their History and Problems; Jamaica; British Guiana; British East Africa; African Colonies; The Rhodesias; At the Source of the Nile; British West Africa; Sudan; Nigeria; Malaya—Life, Scenery and Rural Industries; Rubber and Tin in Malaya; Hong Kong; Falkland Islands; Fiji; Gibraltar; Malta; Cyprus.

IMPERIAL INSTITUTE SCHEME FOR EMPIRE LECTURES TO SCHOOLS.
REGIONAL ARRANGEMENTS—*continued.*

Region.	Counties.	No. of Lecturers available.	Subjects.
6	Buckinghamshire Oxfordshire Berkshire Hampshire Surrey	21	General Empire; Traditions of the British Race; Ties with the Motherland; Colonial Trade and Shipping; The Colonial Empire; Canada; Australia; New Guinea; New Zealand; South Africa; Basutoland; Transkei Territories; Newfoundland; India; India—N.W. Frontier; Burma; West Indies; Bermuda; British Guiana; Bahamas; British East Africa; British West Africa; Travels of Livingstone and Stanley; Ceylon; Straits Settlements; Fiji; Falkland Islands; Palestine; Gibraltar; Malta; Cyprus.
7	Cornwall Devonshire Somerset Dorsetshire Wiltshire Gloucestershire	11	Mineral Resources of the Empire; Canada; South Africa; India; South India; Burma; Ceylon; Aden; Malaya; Hong Kong; Mediterranean Colonies; British East Africa; British West Africa.
8	Anglesey Carnarvonshire Denbighshire Flintshire Merionethshire Montgomeryshire Radnorshire Cardiganshire Brecknockshire Pembrokeshire Carmarthenshire Glamorganshire Monmouthshire	2	Australia—Queensland, New South Wales and South Australia; India; Africa.
9	Staffordshire Warwickshire Shropshire Worcestershire Herefordshire	4	South Africa; Nigeria; Malaya; Ceylon; Palestine; Cyprus.
10	Cumberland Westmorland Lancashire Cheshire	7	General Empire; Raw Materials of the Empire; Empire Cotton; Paper-making Materials of the Empire; Canada; India; With the Mystics of the East; Conquering Everest; Across the Himalayas; Down the Malabar Coast; African Colonies and Protectorates; Nigeria; Malaya; Singapore; British North Borneo; Ceylon; Hong Kong; Gibraltar; Malta.
11	Scottish Counties	3	Union of South Africa; India; The Gold Coast.

IMPERIAL INSTITUTE SCHEME FOR EMPIRE LECTURES TO SCHOOLS.
REGIONAL ARRANGEMENTS—*continued.*

Region.	Counties.	No. of Lecturers available.	Subjects.
12	Sussex Kent	12	General Empire; Dominions and Colonies; Growth of the British Empire; Constitutional Development of Dominion and Colonial Empires; Empire Fellowship; Empire Front; Your Empire School Fellows; The Empire and Peace; Pioneers, Builders, Heroes and Traditions of Empire; Elizabethan Empire Builders; The Colonial System; Cocoa; Coffee; Rubber; Tropical Produce; Canada; Australia; New Zealand; South Africa; Newfoundland; India—Life and Scenery; Early History of the East India Company; Indian Agriculture and Village Life; West Indies; Bermuda; British West Africa; Gold Coast; The Sudan; British Somaliland; Malaya; Sarawak; Fiji; Palestine; Cyprus; Malta.

NOTES

Exhibition Galleries.—For the information of the general public during the enforced closing of the Galleries as a war-time measure, a notice has been issued stating that organised parties will be admitted on application. Facilities are also granted to students and inquirers who wish to inspect particular Courts or exhibits.

On April 10 H.R.H. Prince Bernhard of the Netherlands paid a visit to the Imperial Institute accompanied by Jonkheer Ir. van Lidth de Jeude, ex-Minister of the Netherlands Government, and by Lord Hailey and Mr. G. L. M. Clauson, of the Colonial Office. The Director conducted His Royal Highness and party on a tour of the Laboratories, Intelligence Offices and Library of the Institute; also the India and Burma Courts in the Exhibition Galleries; and later they visited the Cinema where a display of films was shown.

On April 24 a visit to the Canadian Court was paid by Miss Sheila Macdonald in company with the Director in preparation for her departure for Canada to join her brother, Mr. Malcolm Macdonald the High Commissioner in Canada for the United Kingdom Government.

On April 25 the Director accompanied Lord Harlech, the newly-appointed High Commissioner for the United Kingdom Government in the Union of South Africa, on a tour of the South African Court. A few days earlier, on April 17, Mr. N. Pritchard, who is to serve under Lord Harlech as Assistant High Commissioner, had visited the same Court.

On May 1 His Excellency Monsieur Valentin-Smith, Governor of the Free French Colony of Gabon, accompanied the Director on a tour of the West African Courts, following a visit to the Laboratories and Intelligence Offices of the Plant and Animal Products Department and the Mineral Resources Department.

On May 21 the Rt. Hon. Ronald Cross, M.P., High Commissioner Designate for the United Kingdom in the Commonwealth of Australia, visited the Imperial Institute. The Director welcomed him on arrival, conducted him round the Australian Court in the Exhibition Galleries and explained the services which the Institute renders to Australia through its Scientific and Technical Departments, and through its circulation of films and lantern-slides of Australia to schools and societies of the United Kingdom.

As recorded in the last issue of this BULLETIN, arrangements have been made with the British Council for visits to the Galleries by organised parties of foreigners who are temporarily resident in this country. The following parties have paid visits during the months of April and May under this scheme:

Saturday, April 5.—A party of Czechs and Belgians from the Surbiton Women's Voluntary Service.

Saturday, April 19.—A party of French and Belgians from the Barnes Women's Voluntary Service.

Monday, April 21.—A party of Belgians, Czechs, Poles and Maltese from St. Pancras Women's Voluntary Service.

Friday, April 25.—A party of Poles from the Anglo-Polish Foyer.

Saturday, April 26.—A party of Czecho-Slovakians from the East Finchley Centre.

Sunday, May 4.—A party of Belgians from the Twickenham Women's Voluntary Service.

Friday, May 16.—A party of Poles from the Anglo-Polish Foyer.

Saturday, May 31.—A party of Belgians and Dutch from the Twickenham Women's Voluntary Service.

A series of enlarged photographs illustrating West African industries was lent for display at the New Order Exhibition held at the Guildhall, Cambridge, April 19-24, and organised by the Cambridge United Council of Christian Witness.

A set of photographs illustrating tin mining in Nigeria and Malaya was lent for the purposes of an exhibition dealing with tin and its utilisation in modern industry organised by and held at the National Museum of Wales.

New Exhibits.—The recent visit to the Mysore Court of Captain S. T. Binstead, Acting Trade Commissioner for the Mysore State in London, has resulted in further additions being made to the silk exhibits in the Court. Hitherto the exhibit has consisted of specimens of eggs, worms, cocoons and mature silk moths, together

PLATE I.

VANCOUVER AND LIONS GATE BRIDGE, BRITISH COLUMBIA.

Reproduced from a new Diorama in the Canadian Court, Exhibition Galleries, Imperial Institute.

facing page 211]

with raw mulberry silk, silk yarns, silk ties and silk handkerchiefs of local manufacture. The new items comprise knitted scarves, socks, shirts, vests and pants manufactured in the Mysore Government factory from silk produced in that State. These garments were presented for exhibition by the Mysore Trade Commissioner and serve as further illustrations of the utilisation of locally produced silk.

In the East African Court the tobacco exhibit has been overhauled and new samples of the variety "Western" from Uganda have been added. These samples consist of specimen hands of locally grown flue-cured tobacco with a typical leaf opened out and mounted flat to show its shape, size and quality.

The reorganisation of the Cyprus Court has been continued with the assistance of the Trade Commissioner for Cyprus; and, although operations in the Mediterranean continue to hold up the supply of the new material already promised by the Cyprus Government, rearrangement of the present exhibits has enabled a more interesting and informative display to be produced. Thus a rearrangement of the series of scenic photographs around a central map, in the form of a travelogue, permits the visitor to make a visual tour of the island and so to gain a more coherent picture of life in the Colony and of its various attractions.

To the Canadian Court has been added a new diorama of Vancouver, displacing an earlier diorama which, through lapse of time, was no longer representative of the modern city and its environs. The new diorama (see Plate I) was carried out in the Imperial Institute Studio and is the work of Mr. Montague Black. The descriptive label for the diorama reads as follows:

Vancouver and Lions Gate Bridge, British Columbia

"The harbour of Vancouver, one of the world's finest natural harbours, is named after Captain George Vancouver, R.N., who on June 13, 1792, sailed through the First Narrows into what is now known as Burrard Inlet. The First Narrows, also known as Lions Gate, are to-day spanned by the longest suspension bridge in the British Empire, connecting the City of Vancouver on the south with the Municipality of West Vancouver on the north shore and displacing the former ferry service.

"The Lions Gate bridge is the principal feature in the foreground of this diorama. The twin towers, each 360 ft. high, support a web of steel suspending a 29 ft. roadway with two 4 ft. sidewalks at a height of 200 ft. above high-water level. The main span between the towers is 1,550 ft. and the two side spans are each 614 ft., making a total suspended span of 2,778 ft.

"The bridge is approached on the north side (*left of diorama*) by means of an overhead crossing and a steel viaduct 2,200 ft. long; whilst on the south (*right of diorama*) the approach is by a 30 ft.

concrete paved road which winds for 6,500 ft. amidst the towering trees of Stanley Park, Vancouver's 1,000-acre playground. The steel for the superstructure of the bridge was fabricated partly locally and partly in Eastern Canada, the fabricated sections being for the most part delivered to site by scows; 4,750 miles of bridge wire were used, each of the two main cables being composed of 2,867 wires. Work on the substructure was commenced on April 1, 1937, and the bridge was opened to traffic on November 12, 1938, and is operated as a toll bridge. The total cost of the bridge and its approaches was $5,700,000.

"The south approach links up with the centre of Vancouver City (*seen in the background*) with its fine modern buildings, including City Hall, Hotel Vancouver, Royal Bank Building, and Marine Building; and the piers, wharves, railways and freight yards of the Canadian Pacific Railway.

"The total area of the harbour is 48 sq. miles with a shore line of 98 miles. Each year thousands of vessels enter and clear from the port which has been aptly named 'Britain's Gateway on the Pacific.'"

In the Australian Court a large coloured map drawn in prospective, showing Port Jackson with Sydney and its magnificent harbour, is now exhibited on the wall opposite the Sydney Harbour diorama. The label accompanying the map reads as follows:

Sydney Harbour

"Sydney Harbour in Port Jackson, New South Wales, was in 1788 the scene of the first British settlement in Australia. Captain Cook had sailed along the coast in 1770 and had named the bay, which he did not explore, Port Jackson. In 1788 the choice by Governor Phillip of Sydney Cove, 5 miles up the harbour, as his place of settlement, was influenced by his finding there deep and safe anchorage for ships and a stream, the Tank Stream, which became the source of the settlement's water supply.

"Phillip, after exploring Port Jackson, described it as containing 'the finest harbour in the world in which a thousand sail of the line may ride in the most perfect security.' From the ocean entrance the Port extends for 20 miles to near the town of Parramatta. Port Jackson owes its form to ancient earth movement resulting in the sinking of a mountain valley of sandstone and the consequent inflow of the waters of the Pacific."

Imperial Institute Stories of Empire Products.—The origin and purpose of this series of posters and leaflets have already been described in this BULLETIN, 1940, **38**, 527, and reference was made to the first four leaflets in the last issue, 1941, **39**, 92.

Two further leaflets have now been prepared completing the series of six as originally proposed. No. V deals with "West Indian

Sugar—from Cane to Candy;" and No. VI with "West African Cocoa and Chocolate—Drink and Food for Young and Old."

The opportunity afforded by the Conference of the Geographical Association held at Edinburgh in April 1941 was taken to bring this series to the notice of the many educational authorities and school teachers who attended the Conference, and the enthusiastic reception accorded to these "stories" indicates that they will fulfil an extremely useful purpose in the teaching of Empire geography. A further series will therefore be projected as soon as the necessary funds for their production become available.

Empire Lantern Slide Library.—The circulation of lantern slides of the Empire to schools, women's institutes, societies and army educational authorities in the United Kingdom during the period February, March and April 1941 is shown in the following table:

	February.	March.	April.
Australia	650	800	200
Canada	350	400	100
New Zealand	100	200	50
South Africa	200	350	50
India	500	900	500
Burma	150	50	—
Territories of the Colonial Empire	1,200	1,650	600
Products of the Colonial Empire	400	150	100
General Tours of the Empire	500	550	450
History of the Empire	350	400	—
	4,400	5,450	2,050

Slides on Gibraltar, Malta, Cyprus, Palestine and the Sudan have been exceptionally popular among air raid shelter lecturers talking on current events.

A new picture talk for circulation with lantern slides on Malaya has been written by Mr. J. Pennefather-Evans, J.P. (recently of the Malayan Colonial Service) and will shortly be printed. The talk opens with the journey from London to Malaya and the geographical situation and climate of the country, and continues to describe the variety of local races, how each came to settle in Malaya, their occupations and ways of living. The rice, tin, rubber and copra industries are illustrated and the talk concludes with a brief account of the importance of Singapore and the conditions of law, order, social security and good government which obtain throughout the country.

A second picture talk has been written by U Myat Tun entitled "Colourful Burma" to accompany 50 coloured slides from photographs supplied by Mr. M. L. Nathan. It describes the colour and romance of Burma, the scenery and boats, houses, temples, pagodas and sculpture, all of which are illustrated in the course of a journey along the Irrawaddy.

Central Film Library.—Mr. Lawrence Thaw visited London in the summer of 1938 in order to make preliminary arrangements for an expedition to take films of India under the auspices of the National Geographical Society of Washington and the American Museum of Natural History in New York. In this he received the assistance of the India Office and the co-operation of the East India Association and the Imperial Institute. In June 1939, the expedition sailed from New York with a staff of four persons, Mr. and Mrs. Thaw and two technical experts; it included 15 tons of equipment and a fleet of five motor vehicles, including a 40 ft. "land yacht." It left Paris in July 1939 and travelled overland *via* Istanbul and Aleppo (which was reached when war broke out) and so *via* Baghdad and Teheran to Kabul and Peshawar. The expedition travelled through India where a number of interesting films was taken, and finally returned by sea from Bombay to New York in the spring of 1940. The expedition was most successful and attracted considerable interest in the United States.

In recognition of the assistance which he had received in London, Mr. Thaw very generously sent to the Library a gift of four prints of colour films of India and three black and white prints of India and Ceylon. A special display of the colour films, attended by the Secretary of State for India and Mrs. Amery, was given in the Institute's Cinema on May 20 under the joint auspices of the East India Association and the Imperial Institute, and in the same programme a colour film entitled "Burmese Highway" by Mr. M. L. Nathan, which had been presented to the Library by the Irrawaddy Flotilla Company, was included. The Cinema was lent on May 26 to the Royal Geographical Society for a display of the same films to their Fellows.

Since the last issue of the BULLETIN considerable additions have been made to all sections of the Library and in this connection the thanks of the Imperial Institute are due to the Colonial Office for the presentation of funds for the purchase of 30 prints of Colonial films. The Institute is also grateful to the Imperial Relations Trustees for a grant which is being spent on new prints of films for the Empire Section of the Library. Other presentations to the Library include a number of new subjects from the British Overseas Airways Corporation and the Empire Tea Bureau, and 5 new prints of existing subjects from the Limmer and Trinidad Lake Asphalt Co., Ltd. During the period in question the stock of 16 mm. prints of Ministry of Information films was increased from 2,000 to 2,500.

Lectures.—The Director's report on the Empire Lectures Scheme is printed on pp. 203-209.

On April 1 the Director delivered an address to the Cambridge Rotary Club on Empire Service, including some account of the work of the Imperial Institute for the Empire.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the three months February, March and April 1941:

FEBRUARY 1941

K. W. BLACKBURNE, Colonial Secretary, The Gambia.
R. COULTHARD, Veterinary Officer, Nigeria.
M. C. GREENE, Chief Justice, Gibraltar.
R. H. GRETTON, Administrative Officer, The Gambia.
P. C. LANCASTER, Senior Assistant Conservator of Forests, Nigeria.
Sir GORDON LETHEM, K.C.M.G., Governor, Leeward Islands.
J. PENNEFATHER-EVANS, J.P., Commissioner of Police, Hong Kong.
R. P. S. WALKER, Principal, Sultan Idris Training College for Malay Vernacular Teachers, Federated Malay States.

MARCH 1941

M. T. HORWOOD, Assistant Conservator of Forests, Gold Coast.
J. D. POLLETT, Geologist, Sierra Leone.
Professor T. S. SIMEY, Adviser on Social Welfare to Comptroller for Development and Welfare, West Indies.

APRIL 1941

K. D. LUKE, Education Department, Straits Settlements.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

VOL. XXXIX. NO. 3. JULY-SEPTEMBER 1941

PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

TWO NEW OCIMUM OILS FROM AFRICA

IN earlier issues of this BULLETIN (1917, **15**, 322; 1918, **16**, 33; 1934, **32**, 236, 530; 1937, **35**, 301) reports were published on samples of the oils of various species of Ocimum. These included *O. americanum* (= *O. canum*) from Nyasaland and the Seychelles, *O. menthaefolium* from Uganda, *O. basilicum*, *O. gratissimum*, *O. sanctum* and *O. viride* from the Seychelles and two unidentified species from Uganda and the Seychelles respectively. A peculiarity of this genus is the diversity in composition of the oils from the various species, the principal constituents in different species including thymol, eugenol, linalool, chavibetol, methyl-chavicole and camphor. In 1937 a sample of another camphor-yielding oil, obtained from *O. kilimandscharicum*, was received from the Government chemist, Sudan. This oil has recently received some attention in East Africa and in view of inquiries that are reaching the Imperial Institute it has been thought desirable to publish the results of this investigation. At the same time the opportunity is being taken of publishing the results of the examination of another new oil (*Ocimum suave*) received from Tanganyika in 1938.

OCIMUM KILIMANDSCHARICUM OIL FROM THE SUDAN

This sample of oil which, as already stated, was received from the Government Chemist, Sudan, in 1937, was stated to represent the total distillate from the leaves of a perennial and easily-cultivated

plant identified at Kew as *Ocimum kilimandscharicum*. The leaves had been stored for several months before distillation and had then yielded about 5 per cent. of oil.

Preliminary tests carried out locally had indicated that the distillate consisted largely of camphor and terpenes. It was desired to ascertain whether the oil would be of commercial interest and if so, whether it would be advisable to export the whole distillate or to press out the oil and ship the camphor separately.

The sample, as received, consisted of about 340 grams of a very pale greenish-yellow oil, which was in the form of a semi-solid mass owing to the separation of camphor.

From a representative portion of the sample, which was allowed to remain for some hours in a refrigerator at a temperature of about $-5°$ C. a yield of 62 per cent. of solid camphor was obtained by filtration and compression. Owing to the small quantity available it was not possible to recover by fractionation the additional camphor remaining in solution in the residual oil, but chemical examination of this latter oil indicated that a further 15 per cent. of camphor was present in solution, making altogether about 77 per cent. of this product in the original sample as received.

The oil was submitted to (*a*) essential oil distillers, (*b*) chemical manufacturers and (*c*) manufacturing druggists in London, who reported on it as follows:

(*a*) The essential oil distillers considered the camphor expressed from the oil to be of normal quality and likely to command the ordinary market price. They described the residual oil as resembling light camphor oil or spike lavender oil in odour, and expressed the view that it should find a ready sale.

(*b*) The chemical manufacturers expressed the opinion that, judging from the small sample submitted to them, if the oil were offered at a reasonable price it should have considerable commercial possibilities provided that its camphor content could be guaranteed within reasonable limits. In their view it would be more profitable to export the entire oil and not to separate the camphor locally. They suggested very tentatively that the oil might be worth 10*d*. to 10½*d*. per lb. in the United Kingdom at the time of their report (November 1937).

(*c*) The firm of manufacturing druggists stated that the camphor obtained from the oil was of good quality and in the form of small crystals very similar to the commercial camphor flowers. The camphor had a somewhat peculiar odour which they could not define, but they were of the opinion that it was a good sample of crude camphor which could be purified to replace the Japanese or synthetic camphor, provided that it can be produced in sufficient quantity and at a low enough cost to compete with those two products.

A firm of plastics manufacturers, who were also consulted regarding the product, pointed out that in connection with the question as to whether the whole oil should be exported from the

Sudan various points might have to be considered, e.g. the facilities for freezing the oil locally, and the cost of such treatment; the cost of transport from the Sudan, and of containers for the camphor and oil respectively; and the market value of the residual oil. They considered that the facilities for freezing would be considerably cheaper in the United Kingdom and that treatment here might probably give an increased yield of camphor, but that it might be necessary to take various current aspects of the camphor problem into consideration before arriving at a definite conclusion. This firm valued the crude oil at a "very approximate estimate" of 7½*d.* to 10½*d.* per lb. (November 1937).

There seems little doubt that a ready market could be found for this oil in the United Kingdom, but its successful exploitation will naturally depend upon the price at which it can be economically produced. The value of the oil must inevitably be comparatively low, as the camphor of which it principally consists would have to compete with imported Japanese camphor, which was currently offered at about 1*s.* 8*d.*–1*s.* 9*d.* per lb. in London (December 1937). The suggested price of only 7½*d.* to 10½*d.* per lb. assigned to the oil by the above-mentioned firms is probably a conservative estimate of its value.

The oil remaining after the extraction of the camphor would probably also be marketable, but its actual value can be properly assessed only when a much larger quantity is available for commercial trials.

Air-dried camphor leaves have been found to yield up to about 2 per cent. of solid camphor with the addition of seldom more than 1 per cent of oil. From time to time consideration has been given in different parts of the Empire to the commercial possibilities of distilling camphor leaves, but with the exception of the distillation of small amounts of camphor and oil for local use (as, for instance, in Burma) the costs of production, in view of the comparatively small yields, have proved too high to render such an undertaking a commercial success. In view, however, of the comparatively high yield of oil obtained in the Sudan from the present plant material, its distillation on a commercial scale is worth serious consideration.

Inquiries were made as to the prospects of obtaining supplies of the oil from the Sudan for further trial, and it was subsequently learnt (in 1939) that difficulties had arisen in the way of obtaining supplies of the plant and that there was little likelihood of obtaining a larger sample of the oil for some considerable period. In reply to a further inquiry regarding the position, the Imperial Institute was informed in 1940 that purification of available seed was proceeding, and that an increased quantity of the plant would be grown that season. The oil, however, was not likely to be available on a commercial scale for some time.

Ocimum kilimandscharicum does not appear to occur in the wild state in the Sudan and the material from which the oil had been

obtained originated from plants sent from Kenya. These appear to have been sent originally as *O. canum*, but the plant in question was definitely identified later at Kew as *O. kilimandscharicum*.

In view of the promising results obtained with the plant in the Sudan, it was considered desirable to approach the Government Chemist, Kenya, with a view to ascertaining the yield and character of the oil from Kenya grown plants. He has informed the Imperial Institute that from these plants he obtained a yield of 0·6 per cent. of oil, but it is understood that four times this yield has been obtained by a planter in Kenya, also from fresh plants.

It is understood that some of the Kenya seed had been sent to the U.S.S.R., where the plants are sometimes referred to as *Ocimum canum* var. *camphoratum*. The yield of oil obtained in that country is said to vary between 0·46 and 0·56 per cent. from the entire green plant, and between 2·0 and 2·5 per cent. from the dried plants. It was found that oil from plants harvested in August contained 47 per cent. of camphor, whereas oil distilled from plants gathered in October contained 74 per cent.

From all these results it seems clear that both the yield of oil and its camphor content are subject to a good deal of variation and particular attention will have to be devoted to a study of the growth of the plant, its preparation, best time of harvesting and so on, with a view to ascertaining the maximum yields of oil or camphor obtainable per acre.

It is of interest to note that the possibility of utilising Ocimum oil as a source of camphor was taken up in the U.S.S.R. some years ago, and during 1936 about 20 tons of medicinal camphor was stated to have been produced in the U.S.S.R. This was obtained from the camphor basil (*Ocimum canum*), a plant introduced into the U.S.S.R. from Northern Africa in 1928, and cultivated on the collective farms in the Southern Regions of the Union—in the Ukraine, the North Caucasus and the Crimea. The area under camphor basil covered 2,850 acres in 1936, and it was hoped to double the acreage the following year, but no more recent figures appear to be available. It was also stated that attempts were to be made to acclimatise the plant in regions further north, as experiments have shown that it can be grown in the Moscow Territory, in the Western Territory and other districts.

In the U.S.S.R. *Ocimum canum* flourishes best in moist localities that are well sheltered from north-east winds. It is grown as an annual and is propagated from seed in nursery beds. The seedlings when sufficiently grown are transplanted into the fields. Harvesting is carried out by cutting down the plant to within 5 to 7 cms. of the ground and the highest camphor yields are said to be obtained by planting thickly and harvesting twice a year. The average yield of camphor from material cut from one hectare is approximately 20 kilograms, but higher yields up to as much as 75 kilograms are stated to have been obtained.

In the U.S.S.R. the usual methods of steam distillation of the green material and the subsequent separation of the solid camphor from the essential oil by cooling are adopted for obtaining the camphor from *Ocimum canum.*

No particulars appear to have been published regarding the actual costs of cultivation and production in the U.S.S.R. and it is not possible to say whether the material is being produced on an economic basis.

Ocimum suave Oil from Tanganyika

A sample of oil, derived from *Ocimum suave* Willd., was sent to the Imperial Institute under the name "Sonolene" oil by the Director of Agriculture, Tanganyika, in April 1938. The only reference to this oil that can be traced in the literature is contained in Perrot's report, "Sur les Productions Végétales indigènes ou cultivées de l'Afrique Occidentale Française," published as *Notice No.* 31, *Trav. Off. Nat. Mat. prem. vég., Paris,* 1929, p. 360. It is there stated that a firm in Grasse who examined the dried plant estimated from a benzine extraction that the yield of oil by steam distillation would be about 0·5 per cent. Owing to the small quantity available the oil was not fully examined, but was stated to have an odour reminiscent of cloves, vanillin and phenol.

The oil received from Tanganyika was examined at the Imperial Institute with the following results:

Specific gravity at 15·5°/15·5° C.	0·9696
Optical rotation αD21° C.	−22·25°
Refractive index nD20° C.	1·5188
Phenols (by absorption in 5 per cent. caustic potash) . . . . *per cent.*	53

A preliminary chemical examination of the oil indicated that it is rich in eugenol: this constituent probably accounts for the whole of the 53 per cent. of phenols present.

The oil is very similar to one from the Seychelles submitted as *O. gratissimum,* of which *O. suave* was at one time regarded as a synonym. The Seychelles oil contained 55 per cent. of eugenol and was also found to contain linalool and methyl chavicol. Judging from its odour the *O. suave* oil also appears to contain these constituents.

The oil was submitted to two firms of essential oil distillers in London. One of the firms expressed the view that although the product could not compete with clove oil or cinnamon leaf oil as a source of eugenol, it might find a fairly ready sale in limited quantities as a perfume for soaps and dental creams. The second firm considered that the non-phenolic portion of the oil might find a limited outlet, possibly at about 10*s.* per lb., but that the phenolic portion would not be worth more than 2*s.* per lb. so that the maximum value of the entire oil might be about 6*s.* per lb. (October 1938).

In connection with these trade opinions it may be pointed out that owing to present alternative sources of vanillin, oils rich in eugenol (and therefore formerly used as raw materials for vanillin production) are now suffering from a depressed market and, as indicated above, it would appear that the non-phenolic portion of the present *O. suave* oil is more likely to render it of commercial interest.

ARTICLE

DYEING AND TANNING PLANTS IN EAST AFRICA

By P. J. Greenway

Systematic Botanist, East African Agricultural Research Station, Amani

This list, arranged in an alphabetical sequence, is the outcome of a request for information about plants that might be of value as sources of dyes and tannins in East Africa.

On consulting the very mixed and limited literature of East African economic botany one is forced to the conclusion that the arts of dyeing and tanning are not now known to the East African native, and there is little evidence that they have been forgotten as a result of European influence. A search in the books written from 1885 onwards by J. Thomson, H. H. Johnson, A. C. Hollis, M. Merker, E. Werth and others is fruitless, and the handbook of the David Livingstone Memorial Museum at Livingstone, Northern Rhodesia, quotes only two dyes under the native names of the trees from which they are derived. This is in contrast with West Africa, where local cloth is, or was, dyed extensively by the natives.

Dyeing in East Africa by means of natural dyes appears to be limited to about three colours, reds from madder and mangrove, black from *Euclea*, and yellows from the coconut, mango or turmeric. These must not be confused with the hut decorations of some tribes where red, black, grey and white earths or clays are used; nor with the brilliant colours of the decorative palm-fibre mats and leather sandals of the coastal peoples. These colours are obtained by cheap synthetic dyes sold by traders. Tanning is little practised, most skins for clothing or adornment being brayed.

It is noteworthy that in the Swahili language there are only three simple adjectives of colour, *-ekundu*, red, *-eupe*, white, and *-eusi*, black. The others are supplied by reference to typical objects, e.g. for yellow *-a kimanjano* or *-a rangi ya manjano*, "colour of turmeric" (*Curcuma domestica*); for brown *-nyekundu nyeusi*, i.e. red-black; *rangi kama ya majani makavu* colour like dry leaves; or *hudhurungi*, an arabic word for a yellowish-brown or light brown

cotton cloth. In default of any word for blue, the English is used, spelt *buluu*. The word *rangi* does duty equally for colour, for dye and for paint.

In trying to obtain information from a native one meets with the added difficulty of colour distinction. A colour is either red, white, black, blue, yellow or green to a native, there being no finer shades. For instance, an African with a pale skin, i.e. coffee-coloured, is *mtu mwekundu*, a red man, and there is confusion also between shades which are browns to an European but reds to a native, and *vice versa*. It follows that colours mentioned in this list must be taken with some reserve.

There has been little commercial interest in the natural dyestuffs recorded in East Africa, but the following might merit attention: WOODS: Logwood, *Haematoxylon campechianum*, has been successfully established; Fustic, *Chlorophora tinctoria*, introduced; Cutch, *Acacia Catechu*, introduced; Sappan-wood, *Caesalpinia Sappan*, introduced. LEAVES: Indigo, *Indigofera* spp., some wild, others successfully cultivated; Henna, *Lawsonia inermis*, wild and there should be no difficulties in getting commercial supplies in the coastal districts. ROOTS AND TUBERS: Madder, *Rubia* spp., wild, limited supplies but cultivation might be possible to increase supplies; Turmeric, *Curcuma domestica*, cultivated to a limited extent. BARKS: Mangrove barks can be a source of dyes, but they are exported as tan barks. FLOWERS: Safflower, *Carthamus tinctorius*, and Saffron, *Crocus sativus*, have been introduced but apparently not established. FRUITS: Persian Berries and Sap Green, from *Rhamnus* spp., have not been tried but one or two indigenous species of the same genus should be investigated. SEEDS: Annatto, *Bixa Orellana*, has been successfully cultivated. LICHENS: Orchil or Cudbear, *Roccella* spp., wild, have been collected in commercial quantities to a certain extent. GUM RESINS: Gamboge, *Garcinia Hanburyi*, has not been tried though *G. xanthochymus* grows well at Amani.

There are only two sources of tannins in East Africa which are of commercial interest. These are wattle bark, from the exotic *Acacia decurrens* Willd. var. *mollis* Lindl. with the wattle extract made from the bark in Kenya, and the indigenous mangrove barks, obtained from the mangrove trees, *Bruguiera*, *Ceriops* and *Rhizophora*, found in scattered mangrove forests down the coast, the greatest concentrations being in the mouth of the Tana River, Mombasa, the Rufiji Delta and South-east Tanganyika. Wattle bark or its extract cannot be used as a dye, but mangrove bark or extract dyes cotton a pale buff and with mordants a whole range of colours can be obtained.

Other sources of tannin materials which might be of interest are: BARKS: Avaram bark, *Cassia auriculata*, has been successfully established; Babul bark, *Acacia arabica*, indigenous. FRUITS: Myrobalans, *Terminalia Chebula* and *T. belerica*, have been

introduced; Divi-Divi, *Caesalpinia coriaria*, has been successfully established in some places. ROOTS: Canaigre, *Rumex hymenosepalus*, was introduced in the early days of Amani, but its cultivation does not seem to have been continued, perhaps because it is an annual or biennial herb. (No woods, leaves or galls of value for tanning have been recorded.)

In the following list the countries in which each plant is found are indicated by the initial letters of: Uganda, Kenya, Tanganyika, Zanzibar (including Pemba), Nyasaland and Northern Rhodesia; by "East Africa" if found throughout. A question mark after the initial letter indicates that the plant has still to be reliably recorded in the area where one would expect to find it. Exotics which have not become naturalized are enclosed in square brackets.

"Introduced" does not imply that they are established or growing in large numbers as many so marked are still in the experimental stage and may only be represented by one or two plants.

As stated, dye colours mentioned must be taken with reserve. It should also be remembered that with different fibres and mordants a range of colours can often be obtained with the same dye. The figures for tannin content have been extracted from the books in the list of references. They are quoted with the reservation that as the methods of estimation are not always stated the figures may not be fully comparable. NU stands for "native uses."

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ACACIA (Tourn.) L. Mimosaceæ.

A number of species are of importance for their tanning barks and pods and for the tannin and dyeing extracts made from the bark and wood.

1 *A. albida* Del. Apple Ring Acacia.

Tannin, bark, 28%, pods, 5%. Tree in riverine forest, U, K, T, N, NR.

2 *A. arabica* Willd. Babul Bark; Sant Pods.

Tannin, bark of stems, branches and roots, 17–36%, pods de-seeded 30–45%, extract up to 60%. *Dyes*, pods, black, red, yellow. Tree in low-rainfall areas, K, T, N. It is possible that most of the so-called *A. arabica* of East Africa should be assigned to *A. subalata* Taub.

3 *A. Bussei* Harms ex Sjöstedt.

Tannin, bark, 17–21%. A much-branched small tree in low rainfall areas, K, T.

[4 *A. Catechu* Willd. Cutch or Black Catechu.

Tannin, wood preferably heart-wood, the extract Cutch, up to 60%. *Dye*, brown, extract Cutch. An introduced tree, T.]

[5 *A. cyanophylla* Lindl.

Tannin, bark, 16–19%. An introduced tree, T.]

[6 *A. decurrens* Willd. var. *dealbata* F. Muell. Silver Wattle.
Tannin, bark sometimes used. An introduced tree.]

[7 *A. decurrens* Willd. var. *mollis* Lindl. Black Wattle.
Tannin, bark, 28–45%. Extract from bark, Wattle extract. An important tannin tree, cultivated, U, K, T, N, NR.]

[8 *A. longifolia* Willd.
Tannin, bark, 15%. An introduced tree, T.]

9 *A. nigrescens* Oliv. (syn. *A. Brosigii* Harms and *A. pallens* Rolfe).
Tannin, bark. *NU.* tanning. A tree, K, T, N, NR.

/10 *A. pennata* Willd.
Tannin, bark. *NU.* in India an article of internal commerce, used in Bombay for tanning fishing nets. Shrub or liane, widespread, U, K, T, N, NR.

[11 *A. pycnantha* Benth. Golden Wattle.
Tannin, bark, air dried bark having up to 50%, one of the richest known. Cultivated tree, K. T.]

[12 *A. saligna* Wendl.
Tannin, bark, 15%. An introduced tree, T.]

13 *A. Seyal* Del. ex Oliv.
Tannin, bark, up to 20%. *Dye*, red. A tree in dry areas, U, K, T, NR.

14 *A. stenocarpa* Hochst. ex A. Rich. (syn. *A. Holstii* Taub.)
Dye. *NU.* a dye in Uganda. A tree, U, K, T.

15 *A. subalata* Taub.
Tannin, pods, up to 25%. A locally common tree in low rainfall areas, K, T.

[16 *A. suma* Kurz.
Tannin, heart-wood, 11%. Indigenous to India and incorrectly recorded from Tanganyika as being used as a tannin bark.]

17 *A. usambarensis* Taub.
Tannin, bark. A tree, K, T, NR.

ADANSONIA L. Bombacaceæ.

18 *A. digitata* L. Baobab.
Tannin, bark. *Dye*, red, roots. A large tree common in some areas, K, T, Z, N, NR.

[ADENANTHERA L. Mimosaceæ.

19 *A. pavoniana* L. Red Sandal-wood.
Dye, red from wood, little used in dyeing. Cultivated tree, T.]

ADENOSTEMMA Forst. Compositæ.

20 *A. lavenia* Kuntze (syn. *A. viscosum* Forst.).
Dye, blue. A weed in swampy places, U, K, T, Z, N ?, NR.

ALBIZZIA Durazz. Mimosaceæ.

21 *A. Lebbek* (L.) Benth.
Tannin, bark, 4% leaves and bark of small branches. *NU.* in India for fishing nets. Doubtfully indigenous, usually planted in East Africa.

ALCHORNEA Sw. Euphorbiaceæ.

22 *A. cordifolia* Muell. Arg. (syn. *A. cordata* Benth.).
Dye, black. *NU.* in West Africa. A shrub or small tree in forest, U, K ?, T, N, NR ?

ALECTRA Thunb. Scrophulariaceæ.

23 *A. melampyroides* Benth.
Dye, golden-yellow, roots and stems. *NU.* in Belgian Congo for dyeing wood. A parasitic herb, N, NR ?

[ALEURITES Forst. Euphorbiaceæ.

24 *A. Fordii* Hemsl. Tung-oil Tree.
Tannin, bark, up to 12%. An introduced tree in East Africa.

25 *A. moluccana* Willd. (syn. *A. triloba* Forst.). Candle-nut Tree

Tannin, bark, up to 6%. *Dye*, used in tanning and dyeing. An introduced tree, T, Z.

26 *A. montana* Wilson. Tung-oil Tree.

Tannin, bark, 6%. Cultivated, U, K, T, N, NR.]

ALLANBLACKIA Oliv. Guttiferæ.

27 *A. Stuhlmannii* Engl.

Dye, red, bark. *NU*. dye. Locally common rain forest tree, T.

[ALLIUM L. Liliaceæ.

28 *A. Cepa* L. Onion.

Dye, yellow-brown, outer scales of the bulb. Cultivated in East Africa.]

ALOE L. Liliaceæ.

29 Some unspecified species of this genus are said to yield dyes. There are no records for any of the East African plants.

AMARANTHUS L. Amarantaceæ.

[30 *A. caudatus* L. Love-lies-bleeding.

Dye, red, inflorescence. *NU*. as a dye. An annual herb frequently cultivated in gardens in East Africa.]

ANACARDIUM L. Anacardiaceæ.

31 *A. occidentale* L. Cashew-nut.

Tannin, bark, up to 10% in Indian trees. *Dye*, black, nearly ripe nuts. *NU*. a tattoo dye by coastal natives. Locally dominant tree in places on the coast, K, T, Z, N, NR ?

Annatto. See *Bixa Orellana*.

ANNONA L. Annonaceæ.

32 *A. chrysophylla* Boj.

Dye, yellow or brown, bark. *NU*. dyeing cloth. A small tree in bush, widespread in East Africa.

ANOGEISSUS Wall. Combretaceæ.

33 *A. Schimperi* Hochst. ex Hutch. & Dalz.

Tannin, leaves, roots and bark, 9–17%. *Dye*, yellow, leaves. *NU*. West Africa tanning goat skins, dyeing leather and cloth. A tree, U ?

ANTHERICUM L. Liliaceæ.

34 *A. suffruticosum* (Bak.) Milne Redhead.

Dye, brown, juice from leaves. *NU*. a tattooing dye. A perennial herb, K, T.

APHLOIA Benn. Flacourtiaceæ.

35 In Mauritius *A. theaeformis* Benn. has up to 9% tannin in its leaves. A closely related species, if not the same, *A. myrtifolia* Galp. is recorded in mist forest in K, T, N, and NR. It is not known if it contains tannin.

[ARECA L. Palmæ.

36 *A. Catechu* L. Areca Palm.

Tannin, nuts and an extract from them ("Kossa.") *Dye*, nuts and "Kossa." *NU*. dye cotton in Java, tanning action satisfactory. Cultivated in small numbers on the coast, K, T, Z.]

ARISTEA Ker. Iridaceæ.

37 *A. alata* Baker.

Dye. *NU*. used by the Washambaa with the sap of bracken (*Pteridium aquilinum* (L.) Kuhn) as a tattooing dye. Perennial herb, U, K, T.

38 *A. polycephala* Harms.

Dye. *NU*. a tattooing dye in the Iringa District. A rare perennial herb in grassland, T.

ARTOCARPUS Forst. Moraceæ.

39 *A. integra* Merr. (syn. *A. integrifolia* L. f.). Jak or Jack Fruit Tree.

Tannin, bark, 3%. *Dye*, yellow from the wood. *NU*. dyeing cloth. A cultivated and naturalised tree, U, K, T, Z, N ?, NR ?

Avaram Bark. See *Cassia auriculata.*

AVICENNIA L. Verbenaceæ.

The bark of the West African *A. nitida* Jacq. contains 12% tannin and is used as a red dye.

40 *A. marina* Vierh. (syn. *A. officinalis* L.).

Tannin, bark and leaves, leaves about 6%, branch bark up to 3%. *Dye*, brown, bark. *NU.* dye. Local tree along the coast, especially on the margins of mangrove forest, K, T, Z.

Babul Bark. See *Acacia arabica.*

BAPHIA Afz. Papilionaceæ.

41 Camwood, *B. nitida* Lodd., a West African tree, is the source of a red dye. There are no records of any of the East African species having a dye-wood.

BARRINGTONIA Forst. Lecythidaceæ.

42 *B. racemosa* Roxb.

Tannin, bark, Indian samples up to 18%. Locally common tree on the banks of streams and lakes in coastal districts, K, T, Z.

BASELLA L. Basellaceæ.

43 A red-stemmed race, *B. rubra* L. contains a red dye which was used in China for official seals and for rouge. It is sometimes used for colouring jellies. There are no records of the green-stemmed race, *B. alba* L., locally common throughout East Africa, being used as a dye.

BAUHINIA L. Caesalpiniaceæ.

44 *B. Petersiana* Bolle.

Tannin, brown extract from the root. *NU.* in Katanga as a tannin. A shrub or small tree, T, N, NR.

45 *B. Thonningii* Schum. Camel Foot.

Tannin, bark, smaller twigs over 20%, larger branches and roots up to 18%. *Dye*, red-brown, boiling and macerating roots; black or dark blue, pods and seeds. *NU.* West Africa tanning and dyeing. Locally common small tree in East Africa.

[BIXA L. Bixaceæ.

46 *B. Orellana* L. Annatto.

Dye, orange, seeds covered with a mealy substance Annatto, yellow-brown, leaves. *NU.* colouring foods and cloth. A cultivated shrub, U, K, T, Z, N, NR ?]

Black Catechu. See *Acacia Catechu.*

Black Wattle. See *Acacia decurrens* var. *mollis.*

BOMBAX L. Bombacaceæ.

It has been recorded that the old bark of the Indo-Malaysian *B. malabaricum* DC. contains 7% tannin.

47 *B. rhodophagnalon* K. Sch. Brown Cotton Tree.

Dye, reddish-brown, bark. *NU.* dye. A local tree in coastal districts, K, T.

48 *Bombax* sp.

Dye, brown, bark. *NU.* in Zanzibar a dye. Tree, Z.

BORASSUS L. Palmæ.

49 *B. aethiopium* Mart. Deleb Palm.

Dye, red, skins of the seeds. *NU.* in Zanzibar a dye, seed skins pounded and cold water added. Widespread palm in East Africa.

BOSQUIEA Thou. Moraceæ.

50 *B. Phoberos* Baill.

Dye, red from milky sap. *NU.* a Washambaa dye. Locally common tree in dry and wet evergreen forest, U, K, T, Z.

BRACHYSTEGIA Benth. Caesalpiniaceæ.

51 A number of botanically undetermined species have tanning barks, their tannin content ranges from 6–30%. Woodland trees, U, rare. K, local. T, common. N and NR, dominant.

BRACKENRIDGEA A. Gray. Ochnaceæ.

52 *B. zanguibarica* Oliv. (syn. *Ochna alboserrata* Engl.)

Dye, yellow, bark. *NU.* as a dye. A much-branched small tree with rough yellow bark, T.

BRIDELIA Willd. Euphorbiaceæ.

53 In Zanzibar the bark of an unidentified species when pounded mashed in water gives a brown dye and the fruits a black dye. It is probably *B. micrantha* Muell. Arg.

54 *B. micrantha* Muell. Arg.

Tannin, bark. *Dye*, red, bark. *NU.* tanning and dyeing. French West Africa, a black dye, used on pottery, from the young twigs and leaves. A locally common tree especially in secondary forests in East Africa.

BRUGUIERA Lam. Rhizophoraceæ.

55 *B. conjugata* Merr. (syn. *B. gymnorrhiza* Lam.). Mangrove.

Tannin, bark, up to 53%. *Dye*, black, with appropriate treatment orange-reds, brown and violet shades. One of the dominant components of mangrove forests on the coast, K, T, Z.

BURKEA Benth. Caesalpiniaceæ.

56 *B. africana* Hook.

Tannin, bark and husks of fruits but not seeds. *NU.* bark for tanning in S.W. Tanganyika. Locally common in dry deciduous woodland, U, T, N, NR.

CAESALPINIA L. Caesalpiniaceæ.

[57 *C. coriaria* Willd. Divi-Divi.

Tannin, dried pods, 30–50%, in Tanganyika trees 42%, extract 80%. *Dyes*, black, pods; red, from timber. Cultivated, planted as a shade tree and hedge, U, K ?, T.]

[58 *C. Sappan* L. Sappan-wood.

Tannin, bark, pods 44%, leaves 19%. *Dyes*, red, heart-wood; black with iron, pods. Introduced tree, T.]

59 *C. Volkensii* Harms.

Dye, red, roots. *NU.* dye. Local liane in rain forest, T.

[CALENDULA L. Compositæ.

60 *C. officinalis* L. Garden or French Marigold.

Dye, yellow, flowers used as a substitute for saffron. Cultivated.]

[CAMELLIA L. Theaceæ.

61 *C. sinensis* (L.) Kuntze (syn. *Thea sinensis* L.). Tea.

Tannin, leaves 9–15%. Cultivated shrubs, U, K, T, N, NR ?]

Camwood. See *Baphia nitida.*

Canaigre. See *Rumex hymenosepalus.*

CARDIOGYNE Bur. Moraceæ.

62 *C. africana* Bur.

Dye, yellow, the red very heavy heart-wood. *NU.* a dye. Locally common shrub or small tree, K, T, Z, N.

[CARTHAMUS L. Compositæ.

63 *C. tinctorius* L. Safflower.

Dyes, red, shades of bright pinks and yellow, but, unfortunately, the red and pinks are very fugitive, florets. Introduced herb, K.]

CASSIA L. Cæsalpiniaceæ.

[64 *C. auriculata* L. Avaram or Turwad Bark.

Tannin, bark, up to 24% the tannin content rising with age. *NU.* India for tanning, giving a buff coloured leather. Introduced, K?, T.]

65 *C. didymobotrya* Fres.

Tannin, bark. *NU.* in Kenya for tanning. Locally common shrub above 4,000 ft. alt., U, K, T. Introduced, N, NR?.

[66 *C. Fistula* L. Golden Shower; Indian Laburnum.

Tannin, bark and leaves, bark 18%. Introduced, K ?, T, Z ?, N.]

[67 *C. javanica* L.
Tannin, bark. Introduced, U.]

[68 *C. siamea* Lam. Iron-wood.
Tannin, bark 9%, leaves 7%, pods 6%. *Dye*, heart-wood colours clothes. Cultivated tree, planted as an avenue, wind-break and fuel tree in East Africa.]

69 *C. singueana* Del. (syn. *C. goratensis* Fres.).
Tannin, bark. *NU*. tanning. Locally common shrub in secondary bush in East Africa.

CASSYTHA L. Lauraceæ.

70 *C. filiformis* L.
Dye, brown. *NU*. stems pounded and mashed in water used as a dye. A semi-parasitic herb locally common in areas of high rainfall in East Africa.

CASUARINA Rumph. Casuarinaceæ.

71 *C. equisetifolia* L. Beefwood; Ironwood.
Tannin, bark 15–18%. *Dye*, light reddish drab, bark. *NU*. a dye. A locally common tree above high-water mark on sandy sea-shores, K, T, Z. Planted, U, N, NR ?.

Catechu. See *Acacia Catechu*.

[CEDRELA L. Meliaceæ.

72 *C. Toona* Roxb. Toon Tree.
Dyes, yellows and reds, some of the colours are impermanent, flowers. Introduced tree, U, K ?, T, Z ?, N, NR ?.]

CEIBA Mill. Bombacaceæ.

73 *C. pentandra* Gærtn. (syn. *Eriodendron anfractuosum* DC.). Kapok Tree.
Tannin, bark, in too small amount for tanning. *Dye*, red-brown bark. *NU*. dyeing fabrics. A cultivated tree and naturalised in places in East Africa.

CEPHALOSPHÆRA Warb. Myristicaceæ.

74 *C. usambarensis* Warb.
Dye, brown, bark. *NU*. dyeing cloth in the Usambaras. A locally common rain forest tree in the East and West Usambaras, T.

[CERATONIA L. Cæsalpiniaceæ.

75 *C. Siliqua* L. Carob Bean.
Dye, khaki, wood, at one time of commercial value. Introduced tree, K, T, N, NR.]

CERIOPS Arn. Rhizophoraceæ.

76 *C. Tagal* C. B. Robins. (syn. *C. Candolliana* Arn.). Mangrove.
Tannin, bark, 24–42% one of the sources of mangrove bark in East Africa. *Dyes*, black, browns and purples, bark. A locally common tree in mangrove forest, K, T, Z.

Chay-root. See *Oldenlandia*.

CHENOPODIUM L. Chenopodiaceæ.

77 In India *C. album* L. as a decoction is used as an adjunct in indigo dyeing. There are no dye records for any of the species found in East Africa.

CHLOROPHORA Gaud. Moraceæ.

[78 *C. tinctoria* Gaud. Old Fustic.
Dyes, yellows, browns, olives and greys, wood. An introduced tree, T.]

CHROZOPHORA Neck. Euphorbiaceæ.

79 *C. plicata* A. Juss.
Dye, purplish-blue, fruits. A rare annual herb, T, NR ?.

[CHRYSOBALANUS L. Rosaceæ.

80 It has been reported that there is a large amount of tannin in the pulp of the fruit of *C. Icaco* L., coco-plum; if used by itself it produces a soft and porous leather. Introduced shrub, T.]

CLITORIA L. Papilionaceæ.

81 A climber, *C. Ternatea* L., with blue or white flowers which are said to be used to give fleeting colours to cloth. It is widespread and commonly cultivated in East Africa.

COCHLOSPERMUM Kunth. Cochlospermaceæ.

82 *C. tinctorium* Rich.

Dyes, yellow or brownish-yellow, with indigo green, rootstock. *NU.* in West Africa for dyeing cloth, thread, mat fibres and leather, also for colouring food. A shrub, U ?.

[COCOS L. Palmæ.

83 *C. nucifera* L. Coconut.

Tannin, catechol tan, dust from coconut husks. *Dye*, green, milk from nuts and sap with indigo; yellow, husks of the young fruits; brown, the unfertilised female flowers. *NU.* in the East, tanning a very good soft brown leather; dyeing. Cultivated extensively in the coastal districts, K, T, Z.]

COMBRETUM L. Combretaceæ.

A number of West African species yield tanning and dyeing materials.

84 *C. Hartmannianum* Schweinf.

Tannin, bark over 12%. U ?.

85 *Combretum* sp.

Dye, sap. *NU.* in Uganda formerly used to dye bark cloth, U.

COMMELINA L. Commelinaceæ.

86 In India and China the sap of the flowers of *C. benghalensis* L. is used as a colour. It is a widespread herb in East Africa but there are no records of its use, or of other species being used as dye plants by the natives.

COMMIPHORA Jacq. Burseraceæ.

87 *C. pilosa* Engl.

Dye, reddish-brown, bark. *NU.* bark pounded and well boiled used for dyeing cloth. A locally common tree, U, K, T, Z, N, NR ?.

CONYZA L. Compositæ.

88 *C. persicifolia* Oliv. & Hiern.

Dye, black, sap from leaves. *NU.* as a dye in the Belgian Congo. A shrub, U, K ?, T.

CRATERISPERMUM Benth. Rubiaceæ.

89 *C. laurinum* Benth.

Dyes, yellow or brownish, bark and leaves. *NU.* in Sierra Leone the bark and leaves are beaten up and boiled and used for dyeing cloth, etc. A shrub or small tree in areas of high rainfall, U, K, T, Z, N, NR ?.

CREMASPORA Benth. Rubiacaæ.

90 *C. africana* Benth.

Dye, blue-black, fruits. *NU.* in West Africa as a cosmetic for face or body. Much-branched shrub, U, K, T, Z, N, NR ?.

CROCOSMIA Planch. Iridaceæ.

91 *C. aurea* Planch. (syn. *Tritonia aurea* Pappe).

Dye, yellow, flowers, a substitute for saffron. A perennial grass-like herb, U ?, K, T, N, NR.

[CROCUS L. Iridaceæ.

92 *C. sativus* L. Saffron.

Dye, saffron, stigmas, sometimes anthers. Used for dyeing food, to limited extent fabrics and as a flavouring. Introduced perennial herb, K.]

CROTALARIA L. Papilionaceæ.

93 *C. retusa* L.

Dye, plant. A local annual herb, K, T, Z.

[94 *C. striata* DC.
Dye, black, plant. Introduced herb, U, K ?, T, Z, N ?, NR ?.]

[CURCUMA L. Zingiberaceæ.
95 *C. domestica* Valeton (syn. *C. longa* L.). Turmeric.
Dyes, yellows, rhizomes. Uses, as a colouring matter in medicines, confectionery and of curry powders. Cultivated perennial herb, U, K, T, Z, N, NR ?.]

Cutch. See *Acacia Catechu*.

Cutch, Borneo. See *Rhizophora mucronata*.

DATURA L. Solanaceæ.
96 *D. Metel* L.
Dye, green, leaves. *NU*. dyeing cloth. A locally common herb, U ?, K, T, Z, N ?, NR ?.
97 *D. Stramonium* L. Thorn-apple.
Dye, green, leaves. *NU*. dyeing cloth. An annual herb naturalised in U, K, T, Z ?, N, NR.

DELONIX Rafin. Cæsalpiniaceæ.
98 *D. elata* (L.) Gamble (syn. *Poinciana elata* L.).
Tannin, fruits. A local tree in dry areas, U ?, K, T, N, NR.
[99 *D. regia* (Boj.) Rafin. (syn. *Poinciana regia* Boj.).
Dye, flowers contain dye substance quercetin. Cultivated as an ornamental tree in East Africa.]

DIOSCOREA L. Dioscoreaceæ.
100 In Zanzibar an unidentified species yields a brown dye when the stems and leaves are pounded and mashed in water.

DIOSPYROS L. Ebenaceæ.
[101 *D. mollis* Griff.
Dye, black, leaves and fruits. *NU*. an important dye plant in Siam. Introduced tree, T.]

Divi-divi. See *Cæsalpinia coriaria*.

DOLICHOS L. Papilionaceæ.
[102 *D. Lablab* L. Bonavista Bean.
Dye, green, leaves. *NU*. in Zanzibar the leaves are pounded and used as a dye. Cultivated annual herb, East Africa.]

ECLIPTA L. Compositæ.
103 *E. alba* Hassk.
Dye, black, plant. *NU*. a tattooing dye. A common weed in East Africa.

ENANTIA Oliv. Annonaceæ.
Two West African species have yellow woods which give yellow and red dyes.
104 *E. Kummeriæ* Engl. & Diels.
Dye, red, wood. *NU*. dyeing. A rare tree in rain forest, East Usambaras, T.

ERYTHRINA L. Papilionaceæ.
105 *E. tomentosa* R. Br.
Dye, brown, bark. *NU*. bark pounded and mashed in water used as a dye. Widespread tree in East Africa.

ERYTHROPHLŒUM Afz. Cæsalpiniaceæ.
106 *E. guineense* G. Don. Ordeal Tree.
Tannin, bark. *Dye*, red, bark. *NU*. in West Africa for tanning and in Senegal as a dye. Local tree in areas of fairly high rainfall, U, K, T, Z, N, NR ?.

[EUCALYPTUS L'Herit. Myrtaceæ.
107 *E. astringens* Maiden (syn. *E. occidentalis* Endl. var. *astringens* Maiden). Mallet Bark.
Tannin, bark, 31–52%. Introduced tree, K, T.
108 *E. cornuta* Lab.
Tannin, bark, 10%. Introduced tree, K.

109 *E. fœcunda* Schau. var. *loxophleba* J. G. Lueh. (syn. *E. loxophleba* Benth.).
Tannin, bark, 10%. Introduced tree, K.

110 *E. globulus* Lab. Blue Gum.
Tannin. Introduced tree and cultivated, U, K, T, N, NR ?.

111 *E. longifolia* Link & Otto.
Tannin. Introduced tree, K, T, N.

112 *E. redunca* Schau.
Tannin, bark 12%. Introduced tree, K, T.]

EUCLEA Murr. Ebenaceæ.

113 *E. bilocularis* Hiern.
Dye, black, roots. *NU*. dyeing native mats. A locally common evergreen shrub, K ?, T, Z.

114 *E. fructuosa* Hiern.
Dye, black, roots. *NU*. dyeing native mats. A locally common evergreen shrub, K, T, Z, N, NR.

115 *E. Kellau* Hochst.
Dye, black, roots. *NU*. for dyeing. A tree, U, K, T.

EUGENIA L. Myrtaceæ.

[116 *E. aromatica* (L.) Baill. Clove.
Dyes, brown, fruit walls; dark-brown, mother of cloves and clove stems. *NU*. in Zanzibar these parts of the inflorescence and fruit are pounded, water and lemon added and the liquid used in dyeing. Cultivated tree, Z.]

[117 *E. Jambos* L. Rose-apple.
Tannin, bark 7%. A much-branched introduced tree, U, K ?, T, Z.]

[118 *E. uniflora* L. (*E. Michelii* Lam.). Pitanga or Cayenne Cherry.
Tannin, bark, about 29%. A cultivated much-branched small tree often planted as a hedge, U, K ?, T, Z ?.]

FICUS L. Moraceæ.

119 *F. capensis* Thunb.
Dye, brown. *NU*. in Zanzibar the bark is pounded and mashed in water and used in dyeing. A widespread tree in East Africa.

120 *F. glumosa* Del.
Tannin, bark. *NU*. tanning. A large tree, U.

121 *F. Mucuso* Welw. ex Ficalho.
Dye, reddish-brown, roots and bark. *NU*. dyeing by the Washambaa. A very local tree, U, K ?, T.

122 *F. platyphylla* Del.
Tannin, bark. *NU*. tanning. A large tree, U.

FLEMINGIA Roxb. Papilionaceæ.
A brilliant orange dye is obtained from Asiatic species; it is seen in Arabian markets as purple or orange-brown coarse powder which gives a brilliant orange colour to silks, not good on wool and useless on cotton. The powder *Waras*, consists of the epidermic glands from the young pods.

123 *F. rhodocarpa* Baker.
Another of the sources of *Waras*. Perennial herb, U, K, T, N, NR.

FLUEGGIA Willd. Euphorbiaceæ.

124 *F. virosa* Baill.
Dyes, red, black, fruits, leaves. *NU*. in Zanzibar the fruits are pounded and mixed with a little hot water and used as red ink; the leaves pounded together with mud then cooked with palm fibres, dye them black. A widespread shrub, U, K, T, Z, N, NR ?.

Fustic, Old. See *Chlorophora tinctoria*.

GALIUM Tourn. Rubiaceæ. Bed-Straws.
A number of species in Europe and North America yield a red

dye which is obtained from the roots. Some species are found at high altitudes in East Africa but there are no records of the use of their roots by natives for dyeing.

125 *G. Aparine* L. Cleavers or Goose-grass.

Dyes, red, purple with alkali, roots. A perennial herb found at high altitudes, U ?, K, T, N ?, NR ?.

Gamboge. See *Garcinia*.

GARCINIA L. Guttiferæ.

A number of Indo-Malayan species are used for tanning and are the source of Gamboge. There are no records for the East African species.

[126 *G. xanthochymus* Hook. f.

Dyes, yellow from sap of young fruits; black, bark. *NU*. an inferior gamboge paint; dyeing cotton black. An introduced tree, T.]

GARDENIA Ellis. Rubiaceæ.

In West Africa the seeds of several species are used in making a black cosmetic.

127 *G. erubescens* Stapf & Hutch.

Dye, black, seeds. *NU*. cosmetic. A much-branched shrub, U.

128 *G. Jovis-tonantis* Hiern.

Dye, black, seeds. *NU*. as a black stain for the skin. A much-branched small tree, U ?, K, T, N ?, NR ?.

GERANIUM L. Geraniaceæ.

129 A number of American, European and Indian species yield tannins and red dyes. There are as yet no records for those in East Africa.

Golden Wattle. See *Acacia pycnantha*.

[GOMPHRENA L. Amarantaceæ.

130 *G. globosa* L.

Dye, red, plant or flowers. *NU*. a dye. Cultivated herb in East Africa.]

GOSSYPIUM L. Malvaceæ.

131 The flowers of various species of cotton have been used for dyeing; they yield a yellow dye but with mordants different colours have been obtained. The roots also dye, and a blue dye has been obtained from cotton seed. A number of cultivated and wild species are found in East Africa.

Green Ebony. See *Jacaranda mimosæfolia*.

[HÆMATOXYLON L. Cæsalpiniaceæ.

132 *H. campechianum* L. Logwood.

Dyes, red and black, with other dyes browns, olives, greys, etc., wood. One of the most important dye woods to dyers and printers. *Tannin*, wood, 6%. An introduced tree, U, K, T.]

HAGENIA J. J. Gmel. Rosaceæ.

133 *H. abyssinica* J. J. Gmel. (syn. *Brayera anthelmintica* Kunth.).

Dye, yellow, wood. A tree found at high altitudes and more common on volcanic mountains, U, K, T.

HARUNGANA Lam. Hypericaceæ.

134 *H. madagascariensis* Lam.

Dyes, yellow, brown, sap from the trunk, wood. *NU*. for dyeing cloth and grass matting. A common secondary forest tree in East Africa.

HEERIA Meisn. Anacardiaceæ.

135 The South African *H. argentea* Meisn. (syn. *Anaphrenium argenteum* E. Mey.) is recorded as having 33–34% tannin in the bark and over 4% in the leaves and twigs. There are no records for the species found in East Africa.

Henna. See *Lawsonia inermis*.

HERITIERA Ait. Sterculiaceæ.

136 *H. littoralis* Dry. ex Ait.

Tannin, bark, 14–15%. *NU* in the Philippines for toughening fishing nets. A tall tree marginal to mangrove forests, K, T, Z.

HIBISCUS L. Malvaceæ.

[137 *H. rosa-sinensis* L. Shoe-flower.

Dye, black, juice of petals. Used in the east as a hair dye and the flowers for colouring foods. A cultivated ornamental shrub in East Africa.]

[138 *H. Sabdariffa* L. Rozelle.

Dye, gossypetin, petals; red, calyces. Of no commercial value, the calyces are used for colouring foods. Cultivated herb in East Africa.]

HYDNORA Thunb. Hydnoraceæ.

139 The rhizomes of some species contain a large percentage of tannin and are used for tanning skins in the Sudan and South Africa. About five species are recorded in East Africa, they are parasitic herbs on the roots of trees.

[HYMENÆA L. Cæsalpiniaceæ.

140 *H. Courbaril* L. West Indian Locust Tree.

Tannin, bark, 19·2%. An introduced tree, T.]

HYMENOCARDIA Wall. Euphorbiaceæ.

141 *H. acida* Tul.

Tannin, bark. *NU*. sometimes used in Central Africa as a tan; also as a red dye? A small tree, U, K, T, N, NR ?.

142 *H. ulmoides* Oliv.

Dyes, yellow, brown, bark. *NU*. the bark is boiled in water and a yellow extract obtained used for dyeing cloth. In Zanzibar it is pounded and mashed in water and a brown dye obtained. A tree in the coastal districts, K, T, Z.

HYPOESTES R. Br. Acanthaceæ.

143 *H. phaylopsoides* S. Moore.

Dye, pale green, leaves. *NU*. for dyeing raffia fibres in Uganda. A local shrubby herb in U, K ?, T, N.

144 *H. verticillaris* R. Br.

Dye, roots. *NU*. in the Sudan for dyeing mats. A widespread shrubby herb in East Africa.

ILEX L. Aquifoliaceæ.

[145 *I. paraguensis* D. Don (*I. paraguayensis* St. Hil.). Paraguay Tea.

Tannin, leaves, 1–20%. Useless for tanning leather. An introduced tree in K, T, NR.]

IMPATIENS L. Balsaminaceæ.

146 The flowers of *I. Balsamina* L., Balsam, yield a dye and are used for colouring finger nails in China. The plant is an annual herb cultivated in gardens in East Africa. There are no records of native use as dye plants for the numerous East African species.

Indigo. See *Indigofera*.

INDIGOFERA L. Papilionaceæ.

The chief sources of the dye Indigo have been *I. arrecta* Hochst., Africa; *I. articulata* Gouan, India; *I. guatemalensis* Moc. & Sessé, America; *I. suffruticosa* Mill., America; and *I. tinctoria* L., India and Ceylon.

147 *I. arrecta* Hochst.

Dye, indigo, plant. *NU*. in Uganda an infusion of the leaves used for dyeing gourds. Said to be the richest source of indigo and the only true indigenous African species that is of use. A widespread annual or perennial herb, wild or cultivated in U, K, T, Z, N ?, NR ?.

148 *I. articulata* Gouan.

Dye, indigo, plant. A shrub, U ?.

149 *I. diphylla* Vent.
Dye. NU. used as a dye in West Africa. A shrubby herb recorded in East Africa.

150 *I. endecaphylla* Jacq.
Dye, indigo, plant. A procumbent perennial herb wild and cultivated in U, K, T, N, NR ?.

151 *I. hirsuta* L.
Dye, indigo, plant. *NU.* in West Africa as a dye. Locally common annual herb in East Africa.

152 *I. parviflora* Heyne.
Dye, yellow, plant. *NU.* in West Africa used in the preparation of a yellow dye for leather. A herb in U.

153 *I. tinctoria* L.
Dye, indigo, plant. One of the chief sources of indigo. A locally common shrubby herb in U ?, K, T, Z, N ?, NR ?.

IPOMŒA L. Convolvulaceæ.

154 *I. Batatas* Lam. Sweet Potato.
Dye, green, leaves. *NU.* in Zanzibar the leaves are pounded and water added and used as a dye. Cultivated and wild perennial herb in East Africa.

[JACARANDA Juss. Bignoniaceæ.

155 *J. mimosæfolia* D. Don (syn. *J. ovalifolia* R. Br.).
Said to be one of the sources of green ebony, a yellow dye-wood, used in dyeing greens and other compound shades. A cultivated ornamental flowering tree in East Africa.]

JASMINUM L. Oleaceæ.

[156 *J. glabriusculum* Bl.
Tannin, bark and leaves. An introduced climbing plant, T.]

JATROPHA L. Euphorbiaceæ.

157 *J. Curcas* L. Physic-nut.
Dyes, black, sap ; dark-blue, bark ; grey, leaves. *Tannin,* sap, about 10%. *NU.* as a marking ink and a dye. Introduced and naturalised small tree in East Africa.

KHAYA A. Juss. Meliaceæ.

158 *K. nyassica* Stapf. East African Mahogany.
Dye, reddish-brown, bark. *NU.* by the Washambaa as a dye, A riverine tree, K ?, T, N, NR.

159 *K. senegalensis* A. Juss. African Mahogany.
Tannin, bark, about 10%. *NU.* in West Africa for tanning. A forest tree, U, introduced, T.

KIGELIA DC. Bignoniaceæ.

160 *K. pinnata* DC. Sausage Tree.
Tannin, fruits. A much-branched deciduous tree, U ?, K ?, T ?, Z ?, N, NR.

[LAGERSTRŒMIA L. Lythraceæ.

161 *L. speciosa* Pers. (syn. *L. flos-reginæ* Retz). Queen Flower.
Tannin, bark, fruits, 14–17%, leaves, 12–13%. The fruits and leaves have enough tannin to make them suitable for use in a tannin extraction factory, that of the bark and wood of the twigs too poor. Introduced ornamental tree, U ?, K ?, T, Z ?, N, NR.]

LANDOLPHIA Beauv. Apocynaceæ.

162 *L. florida* Benth. Rubber Vine.
Dye, blue, leaves, flowers and twigs. *NU.* as a blue dye in Togoland, the leaves, flowers and twigs are crushed with water and made into small balls and then dried. When used they are placed in water for three days, the lye of fresh wood of *Cussonia Barteri* is added until the taste is bitter. If the liquor is not blue enough to stain the hand held in it, portions of the root of *Morinda lucida* are

added (Volkens, *Notizbl. App.* 22, 3, 119). There are no records of its use as a dye in East Africa. A liane common in evergreen forest in East Africa.

LANNEA A. Rich. Anacardiaceæ.

163 *L. amaniensis* Engl. & Krause.

Dye, red, bark. *NU.* by the Washambaa for dyeing cloth. A very locally common tree in the East Usambaras, T.

164 *L. Stuhlmannii* Engl.

Dyes, brown, deep red, bark. *NU.* the bark is broken and boiled in water for an hour or so and used in dyeing cloth. A locally common tree, U, K, T, Z, N, NR ?.

LAWSONIA L. Lythraceæ.

165 *L. inermis* L. (syn. *L. alba* Lam.). Henna.

Dye, orange-red, leaves. *NU.* the leaves are crushed and mixed with lemon juice and the pulp is put on the finger nails or rubbed into the hair over-night when they become dyed a reddish or auburn colour. In Zanzibar the fresh green leaves are pounded, a lemon is then added and the whole mixed with cold water and used for dyeing cloth a bright red. If the material is hung in the sun it becomes darker, the shade depending upon the length of time in the sun. The colouring matter, lawsone, can be extracted as orange-yellow crystals and used as a dye for wool and silk and is easily fixed. It fixes tenaciously on the human skin. A much-branched evergreen shrub locally common and often dominant in some places, U ?, K, T, Z, N ?, NR ?.

LEPIDOTURUS Baill. Euphorbiaceæ.

166 An Angolan species yields a black dye. There are no records for that in East Africa.

Logwood. See *Hæmatoxylon campechianum.*

LYCOPERSICUM Hill. Solanaceæ.

167 *L. esculentum* Mill. Tomato.

Dye, black, leaves. *NU.* on boiling the leaves a dye is said to be obtained which is used as a cosmetic or for tattooing. Cultivated and naturalised in places in East Africa.

Madder. See *Rubia* spp.

MÆRUA Forsk. Capparidaceæ.

168 *M. cylindricarpa* Gilg & Ben.

Dye, yellow, leaves. *NU.* dyeing native mats. Much-branched evergreen shrub in the coastal districts, K, T, Z.

Malabar Kino. See *Pterocarpus Marsupium.*

Mallet Bark. See *Eucalyptus astringens.*

MANGIFERA Burm. Anacardiaceæ.

In India *peori* dye was obtained by feeding old leaves of *M. indica* to cattle. The leaves contain a poisonous substance which is eliminated by the kidneys and if fed continuously ultimately kills the cattle, during this period the urine contains a yellow dye. Peori dye (Indian Yellow) was a commercial product in India but its cruel methods of preparation are now illegal.

169 *M. indica* L. Mango.

Tannin, bark, 16%. *Dyes*, yellow, bark; red, skins of fruits; yellowish drab and grey shades, fruit pulp. *NU.* dyeing cloth. A naturalised tree, U, K, T, Z, N, NR ?.

Mangrove. See ***Bruguiera conjugata*, *Ceriops Tagal* and *Rhizophora mucronata*.**

[MILLINGTONIA L. f. Bignoniaceæ.

170 ***M. hortensis*** L.

***Tannin*.** An introduced tree, K ?, T ?, Z.]

MIMOSA L. Mimosaceæ.

171 ***M. pudica*** L. Sensitive Plant.

***Tannin*, roots, up to 10%. A perennial shrubby herb in T, Z, N.**

MIMUSOPS L. Sapotaceæ.

It is believed that the bark of several East African species are used for dyeing but there is at present no definite information.

[172 *M. Elengi* L.

Tannin, bark, up to 7%. *Dyes*, browns, bark. Used for dyeing. An introduced tree, T.]

MIRABILIS L. Nyctaginaceæ.

173 *M. Jalapa* L. Marvel of Peru.

Dye, red, sap from reddish leaves. *NU*. in the Belgian Congo for tinting the nails. Cultivated and naturalised annual herb in East Africa.

MORINDA Vaill. Rubiaceæ.

Morindas yield a dye which gives permanent shades of red, purple and chocolate. The dye is present chiefly in the root bark and increases in quantity during the first years of their growth but disappearing in the old roots. The dye is a crystalline yellow substance, morindin, allied to madder and is a dye not so easily used as some others.

174 *M. asteroscepa* K. Sch.

There is no record of this tree being used as a dye; it has a yellow wood, and a very restricted distribution only being recorded from the East and West Usambaras, T.

175 *M. lucida* Benth.

Dye. *NU*. in West Africa as a dye. A tree in evergreen forest, U, K ?, T.

MORINGA Juss. Moringaceæ.

176 Thonner, *Flowering Plants of Africa*, p. 229 (1915) states that *M. oleifera* Lam. (syn. *M. pterygosperma* Gaertn.), Horse-radish Tree, is used as a tanners bark, but search in the literature available does not confirm this statement. It has also been stated in Jamaica literature and elsewhere that the wood yields a blue dye. Locally common and usually planted near native huts, U, K, T, Z, N ?, NR.

MUCUNA Adans. Papilionaceæ.

177 *M. pruriens* DC. Buffalo Bean.

Dyes, black, greenish, leaves. *NU*. in Zanzibar for dyeing matting, cloth and leather. A climbing herb common in places in East Africa.

MUSA L. Musaceæ.

178 The plantain, *M. paradisiaca* L., and banana, *M. sapientum* L., have a sap which stains black or very dark brown, the stain cannot be removed by ordinary methods. In Zanzibar the sap of either is used in a number of ways for dyeing cloth. Some species are said to be used in tanning and dyeing and banana pulp it is said can be used with chemicals to dye wool, silk, cotton, leather, wood, etc., a variety of colours, but the process has only an academic interest. There are no records of any of the wild East African species being used by the natives for dyeing or tanning.

MYRICA L. Myricaceæ.

179 In *M. Nagi* Thunb., found in India, China and Japan, nearly 14% tannin has been recorded in its bark and there are other species with lesser amounts. There are ten species in East Africa, but there are no records of their use by the natives for tanning or dyeing.

Myrobolans. See *Terminalia Chebula*.

[MYRTUS L. Myrtaceæ.

180 *M. communis* L. Myrtle.

Tannin, bark and leaves. An introduced shrub, T.]

NYMPHÆA L. Nymphæaceæ.

181 The roots of a number of European and American species are recorded as containing tannins and another is said to be used in dyeing. There are no records for the East African species.

OCHNA L. Ochnaceæ.

182 Said to be the source of a dye-stuff, there are no records for the many species found in East Africa.

OLDENLANDIA L. Rubiaceæ.

The Indian *O. umbellata* L. is the source of the dye *chayroot* which is obtained from wild and cultivated plants. The dye is obtained mainly from the root bark and is brought out by the use of alkali. It gives a shade of turkey red and in many respects resembles the dye madder. This species is not found in East Africa.

183 *O. corymbosa* L.

Dye, red, root bark. Another source of *chayroot*. An annual herb found as a weed in sandy soils throughout East Africa.

Old Fustic. See *Chlorophora tinctoria*.

OPUNTIA Haw. Cactaceæ.

184 Various species are the hosts of the cochineal insect from which the dye is obtained. *O. Dillenii* Haw. and one or two others are becoming naturalised in East Africa. It was originally introduced into many countries as the host plant of the cochineal insect.

Orchil or Orchilla. See *Roccella*.

ORYZA L. Gramineæ.

185 *O. sativa* L. Rice.

Dye, black, grains. *NU*. in Zanzibar the grains are roasted and mixed with soot, pounded together and water added and used as a dye. Cultivated throughout East Africa.

OSMUNDA L. Osmundaceæ.

186 *O. regalis* L. Royal Fern.

Tannin. The European plant is said to be rich in tannin but apparently is not used in tanning. A local fern, U, K, T, N, NR.

OSYRIS L. Santalaceæ.

187 *O. abyssinica* Hochst.

Tannin, twigs and leaves, 12–25%. Used for tanning in South Africa. A much-branched shrub or small tree, U. K. T. N. NR.

PARINARI Aubl. Rosaceæ.

188 *P. curatellæfolia* Planch.

Dye, red, young leaves. *NU*. in West Africa as a dye. A locally common tree, U, K ?, T, N, NR.

189 *P. excelsa* Sabine (*P. Holstii* Engl.).

Tannin, ashes of the bark and wood. *Dye*, shell and pulp of fruit. *NU*. in West Africa for preparation of skins in tanning and for dyeing. A rain forest tree, U, K ?, T, N, NR.

190 *P. Mobola* Oliv.

Dye, reddish-brown, bark. *NU*. bark pounded and cooked and used as a dye in Zanzibar. A tree, K ?, T, Z, N, NR.

PARKIA R. Br. Mimosaceæ.

191 *P. filicoidea* Welw.

Tannin, bark, 12–14%. *Dye*, red-brown, bark. *NU*. in Eastern Sudan, tanning producing a dark coloured leather. A local tree usually found in fringing forest, U, K ?, T, N, NR ?.

PEMPHIS Forst. Lythraceæ.

192 *P. acidula* Forst.

Tannin, bark, 19–43%. Used for tanning. A much-branched small tree found only on coral by the sea above high-water mark, K, T, Z.

Peori Dye. See *Mangifera indica*.

PHASEOLUS L. Papilionaceæ.

[193 *P. vulgaris* L. French or Kidney Bean.

Dye, yellow, leaves. *NU*. in Zanzibar the leaves are pounded and cooked in hot water but not boiled and the liquid used for dyeing cloth. An annual herb cultivated in East Africa.]

PHŒNIX L. Palmæ.

194 *P. reclinata* Jacq. Wild Date Palm.

Dye, brown, roots. *NU.* in Zanzibar roots pounded and mashed in water and liquid used for dyeing. Widespread palm especially in swampy places in East Africa.

PHYLLANTHUS L. Euphorbiaceæ.

195 *P. floribundus* Muell. Arg.

Dyes, black, plant; brown, bark. *NU.* boiled in water and used for dyeing native mats. In Zanzibar bark pounded and mashed in water used for dyeing. A scandent shrub or climber, U, K, T, Z.

196 *P. Niruri* L.

Dye, black, stems and leaves. *NU.* a dye for cotton and ink. A much-branched annual herb, U.

197 *P. reticulatus* Poir.

Dye, black, bark and roots. *NU.* bark used for staining fishing lines; dye obtained from roots used in dyeing fishing lines. An erect much-branched shrub, U, K, T, Z, N, NR ?.

PHYTOLACCA L. Phytolaccaceæ.

198 *P. dodecandra* L'Herit.

Dye, red, fruits. *NU.* as a dye. A scandent shrub or liane, U, K, T, N, NR.

[PIMENTA Lindl. Myrtaceæ.

199 The fruits, leaves and bark of *P. officinalis* Berg., allspice, contain tannin. That in the leaves could be extracted as a by-product of pimento oil distillation to be used in the country of origin. An introduced tree, T, Z.]

[PISTACIA L. Anacardiaceæ.

200 *P. Terebinthus* L.

Tannin, fruits. *Dyes*, red and black, fruits. Tanning and dyeing. An introduced tree, U, K, T, Z ?, N ?, NR.]

[PITHECELLOBIUM Mart. Mimosaceæ.

201 *P. dulce* Benth.

Tannin, bark, 25%, extract or cutch from bark, 52%. *Dye*, yellow, bark. Much used for tanning skins in the Philippine Islands. Introduced small tree or shrub sometimes grown for hedges, U, K, T, Z ?.]

POINCIANA L. Cæsalpiniaceæ.

[202 *P. pulcherrima* L. (syn. *Cæsalpinia pulcherrima* Swartz). Barbados Pride.

Tannin, leaves, 7%, wood, about 3%. Cultivated throughout East Africa as an ornamental garden shrub.]

PROSOPIS L. Mimosaceæ.

203 *P. africana* Taub.

Tannin, bark, 14–16%. *Dye*, reddish-brown, bark. *NU.* in West and Central Africa used for tanning giving a reddish-brown tint to leather and to dye cloth. A small tree, U.

[204 *P. chilensis* (Mol.) Stuntz (syn. *P. juliflora* DC.). Mesquite.

Tannin, bark; roots, 6–7%. Used for tanning. An introduced shrub, K ?, T.]

PSIDIUM L. Myrtaceæ.

205 *P. Guajava* L. Guava.

Tannin, bark, 30%; leaves, 9–10%. *Dye*, black, bark and leaves. Used for dyeing matting, silk and cotton. A small tree, naturalised in U, K, T, Z, N ?, NR ?.

PTERIDIUM Gleditsch. Polypodiaceæ.

206 *P. aquilinum* (L.) Kuhn. Bracken.

Dye, sap. *NU.* used by the Washambaa with *Aristea alata* Baker, as a tattooing dye. Widespread fern in East Africa.

PTEROCARPUS L. Papilionaceæ.

[207 *P. Marsupium* Roxb. Malabar Kino.

Tannin, kino, 75–80% tannic acid. *Dyes*, brown and brick-red, bark and kino. Used in tanning and dyeing. Introduced tree, T.]

[208 *P. santalinus* L. Red Sanders Wood.

Dyes, reddish-browns, wood. *NU*. in India dyeing and the powdered wood as a cosmetic. Introduced tree, T.]

PTEROLOBIUM R. Br. Cæsalpiniaceæ.

209 *P. exosum* (Gmel.) Bak. f. (syn. *Cantuffa exosa* Gmel.).

Tannin, bark. *Dye*, black, leaves. *NU*. as a tanning material and the leaves crushed in water and iron rust gives a black dye to leather. A thorny scandent shrub, U, K, T, N, NR ?.

PUNICA L. Punicaceæ.

210 *P. granatum* L. Pomegranate.

Tannin, bark of stems and roots, 28%, tannic acid; rind of fruit, 26%. *Dyes*, yellow, black with iron, bark, rind, flowers, leaves. Used in tanning and dyeing and also an ink. Cultivated shrub or small tree, naturalised in some places, U, K, T, Z, N, NR ?.

RAMALINA Ach. Usneaceæ.

211 *R. scopulorum* Ach. var. *cuspidata* Ach.

Dye, red, plant. *NU*. not known. A lichen recorded fror Kilimanjaro, T., and probably found at high altitudes in other parts of East Africa.

RANDIA Houst. Rubiaceæ.

212 *R. maculata* DC.

Dyes, blue-black or black, fruits. *NU*. a dye for fibres; for markings on the face and body or to imitate tattooing. A climber, U.

213 *R. malleifera* (Hook.) Benth. & Hook. f.

Dyes, blue-black, black, fruit juice and seeds. *NU*. in West Africa for staining the skin, cosmetic, tattooing, or as ink. A bush or climber, U, K.

Red Sandal-wood. See *Adenanthera pavoniana*.

Red Sanders Wood. See *Pterocarpus santalinus*.

RHIZOPHORA L. Rhizophoraceæ.

214 *R. mucronata* Lam. Mangrove; Borneo Cutch.

Tannin, bark, 12–50%, Tanganyika bark, 37%, leaves. *Dyes*, deep-brown, reddish-brown, black, bark and leaves. Used for tanning and dyeing, the bark being one of the richest tanning materials, and Borneo cutch is prepared from it. A tree locally dominant in mangrove forests, K, T, Z.

RHUS L. Anacardiaceæ.

The Mediterranean species, *R. Coriaria* L., yields the important tanning material, Sumach.

215 *R. abyssinica* Hochst. ex Oliv.

Tannin, leaves. A tree to 20 ft., U, K.

[216 *R. succedanea* L.

Tannin, leaves, about 13%. Introduced small tree, T.]

ROCCELLA DC. Roccellaceæ.

217 These lichens, commonly known as Orchil, Orchilla Weeds or Cudbear, of which *R. fuciformis* DC., *R. Montagnei* Bel. and *R. tinctoria* DC. are the most important, yield by maceration in ammonia dyes in rich crimson, blues (litmus) and purples. One or two occur in East Africa and have been collected to some extent.

ROYENA L. Ebenaceæ.

218 *R. macrocalyx* Guerke.

Dye, black, roots and bark. *NU*. on the coast the roots are pounded in a mortar and a little water added and used for dyeing palm strips of mats black the strips being soaked in the liquid for two days and then dried in the sun. A shrub K, T, Z, N.

RUBIA L. Rubiaceæ.

This genus is the source of madder, a dye giving red, reddish-brown and purple colours.

219 *R. conotricha* Gandoger.

Dye, red, roots, fruits. *NU*. the Masai wash and boil the roots and the resulting red liquid is used to dye the leather of their sword scabbards. Other tribes soak the ripe fruits in water which give it a bright red colour and is used as ink, dyeing palm leaf and grass for matting and baskets, the dye does not wash out. A perennial herb locally common in bush and grassland at high altitudes, U ?, K ?, T, N, NR.

220 *R. cordifolia* L.

Dye, red, roots, fruits. *NU*. in a similar way to that of *R. conotricha* and probably not specifically distinct. U, K ?, T, N ?, NR ?.

RUMEX L. Polygonaceæ.

221 *R. abyssinicus* Jacq.

Dyes, brick-red and red-brown, rootstock. *NU*. in Abyssinia for colouring butter. In Uganda to give a red-brown colour to raffia fibre woven into mats. A locally common shrub in U, K, T, N, NR ?.

[222 *R. hymenosepalus* Torr. Canaigre or Tanners Dock.

Tannin, roots, fresh 9%, dried 16–48%, or an average of about 30%; extract, 75%. *Dye*, bright orange, tannin. Used for tanning. Introduced annual herb, T.]

Safflower. See *Carthamus tinctorius*.

Saffron. See *Calendula officinalis* (substitute), *Crocosmia aurea* (substitute), and *Crocus sativus*.

SALIX L. Salicaceæ.

223 *S. subserrata* Willd. (syn. *S. Safsaf* Forsk.).

Dye, black, leaves. *NU*. in the Sudan for dyeing mats. A tree, local on river banks, U, K, T, N, NR.

Sant Pods. See *Acacia arabica*.

Sappan-wood. See *Cæsalpinia Sappan*.

SARCOCEPHALUS Afz. ex R. Br. Rubiaceæ.

224 *S. esculentus* Afz.

Dye, yellow, roots, bark and wood. *NU*. in the Sudan as a dye. The dye is not of any special value in Europe. Small tree, U, K ?, T.

[SCHINUS L. Anacardiaceæ.

225 *S. molle* L. Pepper Tree.

Tannin, bark, 23%. Used in South America as a tan bark. An introduced tree, U, K, T, Z ?, N ?, NR ?.]

SCLEROCARYA Hochst. Anacardiaceæ.

226 *S. caffra* Sond.

Tannin, bark, 20%. A tree, K ?, T, Z ?, N, NR.

SIDA L. Malvaceæ.

227 *S. rhombifolia* L.

Dye, black, charcoal. *NU*. in Malaya the charcoal is used for blackening teeth. Locally common weed in East Africa.

228 *S. Schimperi* Hochst. ex A. Rich.

Dye, brown, roots. *NU*. in Uganda the roots are mashed and rubbed on sticks to turn them brown. A dwarf shrub, U, K, T.

Silver Wattle. See *Acacia decurrens* var. *dealbata*.

SOLANUM L. Solanaceæ.

229 The leaves of some unidentified species yield a black dye on boiling which is used as a cosmetic or a tattooing dye. There are numerous species throughout East Africa.

SONNERATIA L. f. Sonneratiaceæ.

230 *S. caseolaris* Engl.

Tannin, bark, over 15%. Used for tanning. A locally common tree marginal to mangrove forests, K, T, Z.

SORGHUM Pers. Gramineæ.

231 In West African *Sorghum caudatum* Stapf var. *colorans* Snowden is grown as a dye plant. Its stems and leaf-sheaths contain a pigment and an extract is obtained from them giving a deep red powder. By various treatments, reds, yellows, blacks and black-purple colours can be obtained. It is not found in East Africa, nor are there any records of other species being so used here, although *S. verticilliflorum* Stapf in age, has dark crimson, sometimes black spotted, and black leaf sheaths. On extraction at Amani the liquid dyed cloth a mauve-purple and gave a blackish-purple powder.

[SPONDIAS L. Anacardiaceæ.

232 *S. Mombin* L. (syn. *S. lutea* L.). Hog-plum.

Tannin, bark. Introduced tree, U, K, T.]

STERCULIA L. Sterculiaceæ.

233 *S. appendiculata* K. Sch.

Dye, yellow-brown. *NU*. used as a dye by the Washambaa. A tall tree locally common in some districts, U. K, T, Z, N.

STROMBOSIA Bl. Olacaceæ.

234 *S. grandifolia* Hook. f.

Dye, black, sap. *NU*. in West Africa for dyeing pottery black. A rain forest tree, U, K, T.

[STRYPHNODENDRON Mart. Mimosaceæ.

235 *S. Barbatima* Mart. Barbatimao.

Tannin, bark, 18-27%, wood, 4%. *Dye*, red, bark. Used for tanning and dyeing in South America. An introduced tree, T.]

SYNAPTOLEPIS Oliv. Thymelæaceæ.

236 In Zanzibar the seeds of an unnamed species is said to be pounded and mixed with cold water giving a red colour.

SYZYGIUM Gaertn. Myrtaceæ.

237 *S. Jambolana* DC. (syn. *Eugenia Cumini* Druce). Jambolan.

Tannin, bark, 18–19%; leaves 12–13% on dry weight of tannin. *Dyes*, purple, fruits; yellow or reddish-brown, bark. *NU*. the fruits are crushed and the pulp strained through a cloth and the liquid boiled with cloth to dye it purple. In Zanzibar the bark is pounded in a mortar and cold water added and used for dyeing palm strips for mats or cloth a yellow or reddish-brown colour. Naturalised and locally common tree on the coast, K, T, Z.

TAGETES L. Compositæ.

[238 *T. patulus* L. African Marigold.

Dyes, with mordants, orange, yellows, browns and black, flowers. Cultivated in gardens in East Africa.]

TAMARINDUS L. Cæsalpiniaceæ.

239 *T. indica* L. Tamarind.

Tannin, bark of old trees, 7%. *NU*. in Java the burnt bark makes an ink. In India and Malaya the fruit pulp is used in fixing dyes especially turmeric and annatto. A locally common tree in East Africa.

TAMARIX L. Tamaricaceæ.

240 Some North African species are of importance on account of the tan galls which are found on them. In some, the tannin content of the galls is high and they are used in tanning and dyeing. *T. nilotica* Ehrenb. a rare riparian tree, found growing in sand is recorded in K, and T; but there is no information about its tanning possibilities.

Tanners Dock. See *Rumex hymenosepalus*.

[TECTONA L. f. Verbenaceæ.

241 *T. grandis* L. f. Teak.

Tannin, leaves 6% on dry weight. *Dye*, yellowish-brown, bark of roots and the leaves. *NU*. in the Celebes root bark for dyeing a yellow-brown. In the Dutch East Indies the young leaves are similarly used. Cultivated tree, U, K, T, Z ?, N, NR ?.]

TEPHROSIA Pers. Papilionaceæ.

242 *T. purpurea* Pers.

Dye, orange-brown, leaves. The leaves contain a glucoside identical with rutin, used for dyeing. An annual or perennial herb, U, K, T, Z ?, N, NR ?.

TERMINALIA L. Combretaceæ.

The genus is of importance in India on account of those species with tanning and dyeing fruits, "Myrobalans."

[243 *T. belerica* Roxb.

Tannin, fruits, leaves, bark. *Dye*, black, fruits. Used in India for tanning and dyeing and an ink is made from the fruits. An introduced tree, T.]

244 *T. Catappa* L. Indian Almond.

Tannin, bark, 11–23%, fruits, 6%. An introduced tree naturalised in places along the coast, K, T, Z.

[245 *T. Chebula* Retz.

Tannin, fruits, 19–51%, extract from the fruits, 50–60%. *Dye*, yellow with alum, with iron ink, fruits. One of the commercial sources of myrobalans used in tanning and dyeing. Introduced, T.]

246 *T. Spekei* Rolfe.

Tannin, fruits, 8%. Of no value as a tanning agent. A tree, U.

247 *T. velutina* Rolfe.

Tannin, bark, 13%. Suitable for local use. A tree to 40 ft., U.

THESPESIA Corr. Malvaceæ.

[248 *T. Lampas* Dalz. & Gibs.

Dye, quercetin, flowers. An introduced shrub, T.]

249 *T. populnea* Soland. ex Corr.

Tannin, bark and wood. *Dyes*, brown and yellow, wood, flowers and capsules. The wood gives an orange-yellow solution which dyes wool a deep brown and the flowers and capsules were used as a dye in India. A coastal tree, K, T, Z.

TREMA Lour. Ulmaceæ.

250 *T. guineensis* Ficalho.

Dyes, reddish-brown, black, coffee-coloured, bark, leaves. *NU*. on the coast the bark is pounded in a mortar, then cold water added and used for dyeing cloth and fishing lines, dried in the shade gives a reddish-brown, if hung in the sun turns black. In West Africa the leaves are used as a coffee-coloured dye which is said to be wash proof. A widespread secondary forest tree in East Africa.

[TRIGONELLA L. Papilionaceæ.

251 *T. Fœnum-grœcum* L. Fenugreek.

Dye, yellow, seeds; if the liquid dye is treated with copper sulphate it gives a fine permanent green. An introduced annual herb, U ?, K, T, Z, N ?, NR.]

Turmeric. See *Curcuma domestica*.

UAPACA Baill. Euphorbiaceæ.

252 *U. sansibarica* Pax.

Dye, blue, roots. *NU*. in Zanzibar the roots are scraped and a powder is obtained, it is boiled a little and the liquid allowed to cool, it will then dye cloth. A local tree, U, K ?, T, Z, N, NR ?.

UNCARIA Schreb. Rubiaceæ.

253 Gambier is an extract obtained from the leaves of *U. Gambier* Roxb., a scandent shrub of western Malaysia; 36–40% tannin is

recorded in the final product. It is used in tanning and dyeing. *U. africana* G. Don, found in West Africa and Uganda does not appear to have any tanning or dyeing properties.

UROPHYLLUM Wall. Rubiaceæ.

Two species are recorded in West Africa as yielding dyes, one a red. There are no records for those found in East Africa.

UVARIA L. Annonaceæ.

254 *U. Kirkii* Oliv.

Dye, black, roots. *NU*. dyeing. An uncommon scandent shrub K, T, Z.

Waras. See *Flemingia*.

Wattle Bark. See *Acacia decurrens*.

WEDELIA Jacq. Compositæ.

255 *W. oblonga* Hutch.

Dye, yellow-brown, flowers. *NU*. in Uganda the flowers are used to give a yellow-brown stain to the stems of tobacco pipes. A herb, U, K.

WHITFIELDIA Hook. Acanthaceæ.

256 *W. longifolia* T. And.

Dye, black, juice from leaves. *NU*. in the Belgian Congo used for dyeing. A shrub in rain forest, U, K, T, Z ?, N ?, NR ?.

WOODFORDIA Salisb. Lythraceæ.

257 The Malaysian *W. fruticosa* (L.) Kurz has 10% tannin in the leaves and 20% in the dried old flowers. The dye quercetin is found in the flowers, it gives slate grey, brown or pink. The rare *W. uniflora* (A. Rich.) Koehne recorded in U, K, T ?, does not appear to have been investigated.

XIMENIA Plum. Olacaceæ.

258 *X. americana* L.

Tannin, bark, 17%. *NU*. in the Sudan sometimes used in tanning. A scandent shrub locally common throughout East Africa.

XYLOCARPUS Koen. Meliaceæ.

259 Two species are represented in and near mangrove forest down the coast of East Africa, but they are by no means common. They are *X. benadirensis* Mattei and *X. moluccensis* (Lam.) Roem. sec. Merr. Both have passed under the names *X. granatum* Koen. or *X. obovatus* A. Juss. the latter synonymous with *X. granatum* which is not found on the East African coast and 41% of tannin has been recorded in one of these two species from East Africa.

ZIZIPHUS Juss. Rhamnaceæ.

260 *Z. Jujuba* Lam. Jujube Tree.

Tannin, bark. *Dyes*, brown, grey, bark. *NU*. in India the bark is used for tanning. On the coast the bark is pounded and mashed in water and used as a dye. Locally common tree throughout East Africa.

DYE INDEX

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NOTES

The Cultivation of the Soya Bean in the United Kingdom.—Serious interest in the possibility of cultivating the soya bean (*Glycine hispida* Maxim.) in this country first arose some thirty years ago, but in spite of investigations that have been undertaken during the intervening period, and of a good deal of publicity, the prospects of any commercial development seem to be as far removed as ever. The soya bean is undoubtedly a crop that appeals to the public imagination, and it has been described in enthusiastic terms, but it is now, however, apparent that if this crop is ever to become established in the United Kingdom it will only be as a result of careful varietal selection and experimental trial.

The establishment of an important oil seed crop such as the soya bean as a permanent feature of British farming would be, nevertheless, a very great development. So great, in fact, that a sustained attempt to solve the problems involved would seem to be justified provided that there could be judged to be any reasonable grounds for anticipating eventual success. As an example of the market for soya beans, some 150,000 tons were imported annually to this country during the years 1932-35, while notwithstanding the imposition of a 10 per cent. duty in 1935 imports still approached 100,000 tons per annum during the next three years. Appreciable quantities of the oil also came in during this period. There is, furthermore, no important Empire production of soya beans so far.

A valuable review of what has been achieved by the various pioneers of the crop in this country appeared in 1936 in an article by Sir John Russell (*Journal of the Ministry of Agriculture*, April 1936, pp. 24-30). Recently Dr. Mann, of Woburn Experimental Station, has published an interesting account of his experiments in the cultivation of soya beans (*Nature*, May 31, 1941, pp. 660-662). Other useful information will be found in *The Soya Bean*, by Elizabeth Bowdidge (Oxford University Press, 1935), which deals in particular with experiments conducted on the Fordson Estates at Boreham, Essex.

Discussing the trials undertaken at Rothamsted and Woburn, which, although made with some of the most promising types of soya bean available, have not been encouraging, Dr. Mann describes three conditions which appear to be necessary for complete success but which are not fully provided by the British climate. Firstly, the crop is rather sensitive to frost; for example, it cannot be sown until serious danger from this is over, i.e. about the end of April, so that the length of the growing season is seriously curtailed. Secondly, a higher temperature is required during the growing season than normally obtains in this country, and in this connection Dr. Mann quotes Sir John Russell's figures for the mean monthly temperatures during the growing season at

Kleinwanzleben, near Magdeburg (*The Times*, March 12, 1941), where satisfactory soya bean yields have been reported, which are significantly higher than those prevailing at Rothamsted. Lastly, the wet autumns that are a feature of the British climate render difficult the drying of a crop that does not ripen before the end of September or the beginning of October. Many soya varieties do not mature until later in the year.

An interesting point is that these experiments have shown that the crop requires land of at least average fertility, and that the by no means uncommon impression that soya beans can be grown on poor land, on account of their leguminous character, is not supported.

In general, soya bean varieties have been found to require an appreciably longer period to reach maturity in this country than elsewhere, while Dr. Mann has never succeeded in obtaining a yield of more than about 6 cwt. of clean seed per acre as compared to a return in the neighbourhood of 15 cwt. per acre in established centres of commercial production.

It should be pointed out, however, that yields superior to those obtained by Dr. Mann have been reported in this country. In 1928, according to Russell, returns estimated at the rate of 900 to 1,150 lb. per acre were obtained in trial plots grown by the National Institute of Agricultural Botany. In 1934, as recorded by Bowdidge, yields of from 15 to 25 bushels (900 to 1,500 lb.) per acre were obtained in field scale trials at the Fordson Estates, Boreham, but this was achieved in a particularly favourable season. It is of interest that the Fordson beans gave on analysis a lower oil content but a higher protein content than typical American and Manchurian grown seed.

This question of yield is of paramount importance. For example, in August, 1939, that is just prior to the outbreak of war, Manchurian soya beans were quoted at £9 2*s*. 6*d*. per ton c.i.f. United Kingdom ports, while during the previous five years the average monthly price had ranged from £4 17*s*. 6*d*. to £9 17*s*. 6*d*. per ton. On the basis of the yields reported by Dr. Mann, and allowing for the duty, though taking no account of the value of the straw, these prices would represent a monetary return of often less and seldom more than about £3 per acre to the potential home producer.

However, Dr. Mann is not unhopeful of the possibility of the ultimate development of types which may yield more heavily under British climatic conditions and at the same time will ripen early enough for successful harvesting here. He stresses, nevertheless, the great amount of work that will be required if the crop is ever to become established here. There would appear to be no grounds on which Dr. Mann's conclusions can be disputed, and the results of his work should do something to prevent undue optimism concerning the possibilities of the soya bean as a farmers' crop in the United Kingdom in the present circumstances.

Investigations of Insecticidal Plants in Puerto Rico.—The Report of the Puerto Rico Experiment Station for the year 1939 (1940) contains a useful account (pp. 71-93) of physiological and cultural investigations that have been carried out with species of Derris, Tephrosia and Lonchocarpus. The main points of these investigations are outlined in the following note:

The physiological work has as its basis the finding of Worsley and Nutman (*Ann. Appl. Biol.*, 1937, **24**, 696-702) that in *Derris elliptica* the rotenone, which is stored in the ground parenchyma of the roots, is restricted to so-called resin cells, distinct both in appearance and function from the starch-storing cells of the parenchyma. The work at the Puerto Rico Experiment Station confirmed this differentiation between resin cells and starch-bearing cells in several species of *Lonchocarpus*, five varieties of *Derris elliptica* and an introduced strain of *Tephrosia toxicariâ*. Further, the relative abundance of the resin cells in any root was correlated with the intensity of response to the Durham test for rotenone.

At an early stage in the work it was noticed that the occurrence and distribution of the resin cells in different roots showed considerable variation and that there was commonly a tendency for one or other of the two types of cell to predominate in alternating concentric bands, giving a pattern easily visible to the naked eye. It appeared that the laying down of tissue with a high proportion of resin cells is associated with rapid flushes in the growth of the plant. Thus plants of *Derris elliptica* grown in sandy soils showed abundant resin cells in root tissue formed at the commencement of the rainy season when the plants were growing vigorously, while starch cells predominated in tissues laid down during the dry season when growth was severely restricted through drying out of the soil. By contrast these alternating bands were far less marked in the roots of plants grown in heavy soils not liable to drying out.

The same principles were found to hold good in the case of branch roots from different parts of the root system. Those arising directly from the base of the vine and growing in the superficial layers of the soil where conditions are unfavourable owing to frequent severe drying, proved to be rich in starch but poor in rotenone. Rootlets growing under more favourable conditions in the deeper layers of the soil were, on the other hand, relatively rich in rotenone.

In extreme types a correlation was noticeable between root form and rate of growth of the root, and, incidentally, its rotenone content, especially in the finer branch roots of *Derris elliptica* (less than about 5 mm. in diameter). Rootlets growing in the dry superficial layers of the soil and consequently poor in rotenone were often definitely tapering in form, while those arising in the deeper and moister layers of the soil, favouring rapid growth and the formation of rotenone-containing resin cells, were roughly cylindrical. As might be expected, many branch roots did not fall

readily into either of these classes, but the extreme types of root form did at least give some general indication of rotenone content.

The effects of exhausting the food reserves of the root were studied in order to determine whether there is any depletion of the stored rotenone. Ten-month-old plants of *Tephrosia toxicaria* and 27-month-old plants of *Derris elliptica* were repeatedly severely pruned until growth ceased and the roots then compared with control plants that had been allowed to grow normally. In the case of the Derris some of the plants were allowed to renew growth after the initial pruning, thus providing a " pruned " series in addition to the " starved series " where any renewed growth was cut back.

The results of these preliminary experiments indicate that in the starved roots of both *Tephrosia toxicaria* and *Derris elliptica* the rotenone compounds were unaffected, though, of course, practically the whole of the stored starch was exhausted. Owing to the loss of the starch the rotenone content of the roots expressed on a dry weight basis was higher than that of the control roots, but figures worked out on a basis of weight per unit volume indicate that this increase is only apparent. Expressed on a volume basis, the total extractives in *Tephrosia toxicaria* showed a marked decrease in the starved roots, but in the case of *Derris elliptica* the loss observed was so slight as to fall within the limits of experimental error, and may not have been caused by starvation of the roots.

As a partial explanation of this difference in the behaviour of the two species tested it is pointed out that in normal plants of *T. toxicaria* the extractives other than rotenone constituted 98·3 per cent. of the total extractives, as compared with a figure of 58·8 per cent. for *Derris elliptica* var. *changi No.* 3.

Various nutrition and manurial investigations are also reported.

Both Derris and Lonchocarpus were found to be sensitive to iron deficiency. Plants of *D. elliptica* grown in sand culture made up with the local natural water exhibited very definite symptoms of chlorosis, unaffected by treatment with boron, copper, manganese or zinc, but quickly corrected by application of ferrous or ferric sulphate. The same chlorotic symptoms, associated with subnormal growth, were observed in several species of Lonchocarpus in the field, and here again the immature leaves were restored by application of iron salts, although the older ones did not recover. It was found that although the local soils contained a large amount of iron oxide their alkaline reaction (*p*H 7·1 to 8·1) allowed only minute traces of iron to remain in solution. That the weed growth showed no symptoms of chlorosis indicates that Lonchocarpus has high iron requirements.

Manurial trials with ammonium sulphate as a fertiliser for *D. elliptica* var. Sarawak Creeping on heavy black soil showed no significant increase in either the rate of growth or the yield of roots from this treatment.

In connection with this experiment an analysis was carried out

of the vertical and lateral distribution of the roots in the ground. It was found that 81 per cent. (air-dry weight) of the roots grew in the upper 16 in. of the soil, and that there was a fairly even lateral distribution within 2 ft. of the parent cutting. Roots reaching below 32 in. were estimated at only about 3 per cent., the longest reaching some 22½ in. into the waterlogged soil below this level.

With regard to planting material attention is called to the high vegetative vigour of a clone of *D. elliptica* obtained from St. Croix (Virgin Islands). In comparative trials with Changi No. 3, the St. Croix plants yielded more than double the weight of roots and showed a much greater capacity to establish themselves under adverse field conditions than the Changi No. 3 plants. Tests with cuttings of the St. Croix variety to determine the effect of diameter and degree of exposure on their capacity for rooting were also undertaken. The results of these indicate that the large and medium diameter groups (15 to 10½ mm. and 10 to 7½ mm.) rooted most readily and that cuttings with only 1 in. exposed above the soil took root more rapidly than those with 4 in. exposed. No analyses of the roots of this variety are reported.

With Lonchocarpus, selection work that has been in progress since 1937 is reported. Two plants found to be particularly rich in rotenone (20·63 per cent. and 14·02 per cent. respectively) have been propagated by budding on to vigorous stocks of an allied species of Lonchocarpus.

A critical survey of Lonchocarpus plants growing in the field revealed variation in growth habit and leaf size, and a large number of plants were tested after classification into two types: (*a*) relatively tall-growing large-leaved plants and (*b*) bushy small-leaved plants. The roots of the latter type proved to have a higher average rotenone content than type (*a*), although the total extractives were slightly higher in type (*a*), which also yielded a greater weight of roots. Biological tests with acetone extracts of the roots against house-flies showed type (*b*) to be the more toxic. Analysis of the data indicated that a number of different clones were concerned.

The Storage of Nuts.—Investigations on the storage of nuts have been carried out by the United States Department of Agriculture over a period of years, the preliminary investigations having begun in 1921. An account by R. C. Wright of the work done has now been published in *Technical Bulletin* No. 770, June 1941, issued by the United States Department of Agriculture, Washington, D.C., and the following summary of the results obtained in the main investigations will no doubt be of interest to producers of nuts in the Empire.

Pecans, Persian (English) walnuts, almonds, filberts, black walnuts and macadamia nuts were stored at different temperatures both in the shell and unshelled. The kernels were stored with ex-

posure to the air and also packed in vacuum, in carbon dioxide, and in nitrogen.

Unshelled pecans stored at 32° F., with a relative humidity of 75 per cent., were good for more than a year after harvest. At 50° they remained good for about 6 months, but at 70° they were found to be stale to rancid in 3 months. Shelled pecans exposed to the air kept satisfactorily at 32° F. from 6 to 10 months, and at 50° F. for about 5 months. When packed in vacuum and stored at 32° F. and at 50° the kernels kept for 2 to 3 years, but at 70° they only kept for 6 to 8 months, and were found to keep better when packed in vacuum than in carbon dioxide. When packed in nitrogen the kernels kept no better than those stored in cloth bags and left exposed to the air. The development of rancidity is especially rapid in pecans and it is suggested that it is probably well under way before it can be detected by taste. For this reason the recommendation is made that, if they are to be kept for more than two or three months, pecans should be put into cold storage soon after harvesting and curing.

A description is also given in the Bulletin of a simple method for the home preservation of pecans, in which the shelled nuts can be processed in fruit jars.

Unshelled Persian (English) walnuts kept almost as well at 50° F. as at 32°. At 32° the Placentia variety remained good approximately 12 to 20 months and at 50° from 15 to 20 months after harvest. The Franquette variety at 32° F. kept from about 10 to 19 months and at 50° from 6 to 10 months. When packed in vacuum the kernels kept longer in good condition at all temperatures than when packed by any other method. There seemed to be little advantage in packing in carbon dioxide or nitrogen, and the results were only slightly better than those obtained by leaving the nuts unshelled.

Almonds in the shell remained in good merchantable condition and with good flavour at 32° F. for well over a year after harvest, and at 50° for almost as long. At 70°, with relative humidity of 75 per cent., they remained good for 6 to 8 months. Shelled almonds stored in cloth bags did not keep satisfactorily as long as unshelled ones. Kernels packed in vacuum, carbon dioxide and nitrogen were good for 15 to 24 months at 32° F. and 50°, and at 70° for 13 months, and there was practically no difference in the results obtained from the three storage atmospheres.

Filberts, like the almonds, deteriorated rather slowly, even at the higher temperatures, where the relative humidity was 65 to 75 per cent. Unshelled or shelled filberts packed in vacuum or carbon dioxide and stored at 32° F., 50° or 70° kept well from a year to 32 months after harvest. Kernels exposed to the air or packed in nitrogen kept less than a year.

Black walnut kernels in cloth bags with exposure to the air kept in good fresh condition for 20 months at 32° F., but at 50° and 70° they were only good for 8 months. Packed in vacuum and

stored at 32° F. and 50° they kept as well as fresh nuts for practically 3 years and at 70° for almost 2 years. When packed in carbon dioxide or nitrogen and stored at 32° the nuts kept in good condition for nearly 2 years, whereas at 50° and 70° they kept for 8 months.

Rather limited tests were carried out on the storage of macadamia kernels, and it was found that these kept well for over a year, whether packed in vacuum, carbon dioxide, nitrogen, or exposed to the air, at 32° F. and 50°, with the exception of those exposed to the air and stored at 50°. At 70° and 80° all the lots were wormy after 7 months, however, and with the exception of those packed in carbon dioxide at 80°, were stale to rancid after a year.

In the course of the investigations it was observed that, before the development of either staleness or rancidity most of the nuts became practically tasteless. After this, staleness usually developed, followed by rancidity in some cases, especially in pecans. Rancidity did not become apparent in all kinds of nuts studied.

Chemical studies were also made in an attempt to determine the time of inception of deterioration before it could be detected by taste. Chemical analyses, including the determination of free fatty acids and aldehydic substances usually associated with rancidity and catalase, were made on all lots, but such chemical tests were found to be unsatisfactory, since the results they yielded could not be correlated with degrees of rancidity as indicated by taste. Consequently this phase of the work was discontinued and the palatability of the nuts was subsequently determined entirely by taste as rated by two or three experts.

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The Economic Biology of Some Australian Clupeoid Fish. By M. Blackburn. *Bull. No.* 138, *Coun. Sci. Industr. Res. Aust.* Pp. 140, 9½ × 6. (Melbourne: Government Printer, 1941.)

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Tuna Fishing in Southern Mindanao. By J. S. Domantay. *Philipp. J. Sci.*, 1940, **73**, 423-436. Illustrated.

The Newfoundland Lobster Fishery: an Account of Statistics, Methods and Important Laws. By W. Templeman. *Res. Bull. No.* 11 (*Fish.*), *Dep. Nat. Resources Newfdld.* Pp. 42, 9 × 6. (St. John's: Department of Natural Resources, 1941.) Price 20 cents.

The Biology and Cultivation of Oysters in Australia. I. Some Economic Aspects. By G. L. Kesteven. *Pamphl. No.* 105, *Coun. Sci. Industr. Res. Aust.* Pp. 32, 9½ × 6. (Melbourne: Government Printer, 1941.)

FORESTRY

General

Report of the Forestry Commission, New South Wales, for the year ended June 30, 1940. Pp. 8, 13 × 8. (Sydney: Government Printer, 1941.) Price 7*d.*

Annual Report on the Operations of the Woods and Forests Department, South Australia, for 1939-40. Pp. 16, 13 × 8. (Adelaide: Government Printer, 1940.)

Annual Report of the Forests Commission, Victoria, Australia, for the year ended June 30, 1940. Pp. 24, 13 × 8. (Melbourne: Government Printer, 1940.) Price 1*s.*

Report on the Forest Department, British Guiana, for 1939. Pp. 9, 13 × 8. (Georgetown, Demerara: "The Argosy" Co., Ltd., 1941.)

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Report on the Forestry Department, Gold Coast, for 1939-40. Pp. 8, 13 × 8. (Accra: Government Printing Department, Publications Branch, 1940.) Price 1*s.*

Forest Research in India, 1939-40. Part II. Reports for Burma and Indian Provinces. Pp. 218, 9½ × 6¼. (Delhi: Manager of Publications, 1941.) Price Rs. 3 As. 12.

Report on Forest Administration in the Andamans for the year 1938-39. Pp. 81, 9½ × 6. (Delhi: Manager of Publications, 1940.) Price Rs. 7 As. 4.

The Forest Resources of Assam. Compiled by M. C. Jacob. Pp. 48, $9\frac{3}{4} \times 6\frac{1}{4}$. (Shillong: Government Press, 1940.) Price As. 7.

Annual Progress Report on Forest Administration in the Province of Orissa for 1939-40. Pp. 81, $10 \times 6\frac{3}{4}$. (Cuttack, Orissa: Superintendent, Government Press, 1940.) Price Rs. 4 As. 4.

Annual Report of the Forestry Department, Nyasaland, for 1940. Pp. 8, 13×8. (Zomba: Government Printer, 1941.) Price 1*s*.

Check-Lists of the Forest Trees and Shrubs of the British Empire. No. 5. Tanganyika Territory. Part I. Compiled by F. B. Hora and P. J. Greenway. Pp. 312, $8\frac{1}{2} \times 5\frac{1}{2}$. (Oxford: Imperial Forestry Institute, 1940.) This part consists of the botanical and vernacular list comprising an alphabetical list of families and genera and a botanical-vernacular index.

Annual Report of the Forest Department, Uganda, for 1940. Pp. 8, 10×6. (Entebbe: Government Printer, 1941.) Price Sh. 1/-.

Twentieth Annual Report of the Southern Forest Experiment Station, New Orleans. Pp. 39, $10\frac{1}{2} \times 8$. (New Orleans: Southern Forest Experiment Station, 1941.)

Forest Resources of South Georgia. By M. M. Lehrbras and I. F. Eldredge. *Misc. Publ. No.* 390, *U.S. Dep. Agric.* Pp. 50, $10\frac{1}{2} \times 8$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 20 cents.

Forest Resources of the Douglas Fir Region [of the United States]. By H. J. Andrews and R. W. Cowlin. *Misc. Publ. No.* 389, *U.S. Dep. Agric.* Pp. 169, $10\frac{1}{2} \times 8$. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1940.) Price 50 cents.

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Natural Regeneration in Western White Pine Type. By I. Γ. Haig, K. P. Davis and R. H. Weidwan. *Tech. Bull. No.* 767, *U.S. Dep. Agric.* Pp. 99, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 20 cents.

Slash Disposal and Forest Management after Clear Cutting in the Douglas Fir Region. By T. T. Munger and D. N. Matthews. *Circ. No.* 586, *U.S. Dep. Agric.* Pp. 55, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 10 cents.

The Control of Seed Origin in Forestry: Methods Adopted in some European Countries and the U.S.A. *For. Absts.*, 1941, **2**, 271-275.

Frost and the Prevention of Frost Damage. By F. D. Young. *Frms'. Bull. No.* 1588 (*Revised*), *U.S. Dep. Agric.* Pp. 65, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1940.) Price 10 cents.

Influence of Altitude and Aspect on Daily Variations in Factors of Forest-Fire Danger. By G. Lloyd Hayes. *Circ. No.* 591, *U.S. Dep. Agric.* Pp. 38, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 10 cents.

Forestry and Farm Income. By W. R. Mattoon. *Frms'. Bull. No.* 1117 (*Revised*), *U.S. Dep. Agric.* Pp. 33, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1940.) Price 5 cents.

Parasites of the Birch Leaf-Mining Sawfly (*Phyllotoma nemorata*). By P. B. Dowden. *Tech. Bull. No.* 757, *U.S. Dep. Agric.* Pp. 56, 9×6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 10 cents.

Uninfected Elm Wood as a Source of the Bark Beetle (*Scolytus multistriatus* Marsham) carrying the Dutch Elm Disease Pathogen. By D. L. Collins, K. G. Parker and H. Dietrich. *Bull. No.* 740, *Cornell Univ. Agric. Exp. Sta.* Pp. 14, 9×6. (Ithaca, N.Y.: Agricultural Experiment Station, 1940.)

Kiemproeven en kiemplanten. I. Acacia. By E. M. Drees. *Tectona*, 1941, **34**, 1-45. Results of germination experiments with eleven species of *Acacia* carried out at the Forest Research Institute at Buitenzorg. With a summary in English.

Culture, Diseases and Pests of the Box Tree. By F. Weiss and L. G. Baumhofer. *Frms'. Bull. No.* 1855, *U.S. Dep. Agric.* Pp. 17, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1940.) Price 10 cents.

Shortleaf Pine. By W. R. Mattoon. *Frms'. Bull. No.* 1671 (*Revised*), *U.S. Dep. Agric.* Pp. 44, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1940.) Price 10 cents. Describes the cultivation of the tree as a crop.

The Little-leaf Disease of Shortleaf Pines. By P. V. Siggers and K. D. Doak. *Occ. Pap. No.* 95, *Sth. For. Exp. Sta.* Pp. 5, 10½ × 8. (New Orleans: Southern Forest Experiment Station, 1940.)

Timber

The Use of the Terms "Hardwoods" and "Softwoods" and some Related Problems. By H. E. Desch. *Tr. Leafl. No.* 4, *Malay. For. Serv.* Pp. 7, 9¾ × 7. (Kuala Lumpur: Adviser on Forestry, 1941.) Price 20 cents.

Nomenclature of Australian Timbers. Part I. Standard Trade Common Names. Part II. Standard Trade Reference Names. Part III. Common Names and their Appropriate Standard Trade Common Names and Standard Trade Reference Names. *Tr. Circ. No.* 47, *Coun. Sci. Industr. Res. Aust.* Pp. 84, 9 × 6. (Melbourne: Government Printer, 1940.)

American Timbers of the Mahogany Family. By S. J. Record. *Trop. Woods*, 1941, No. 66, 7-33.

A Note on Semal (*Bombax malabaricum* D.C.). By Jagdamba Prasad. *Indian For.*, 1941, **67**, 171-183. Contains information on the uses of the timber and on other products obtained from the tree.

Notes on the Susceptibility to Insect Attack of Philippine Woods. By H. F. Varian and A. C. Gallardo. *Philipp. For. J.*, 1940, **3**, 347-380.

The Effect of Certain Heart Rot Fungi on the Specific Gravity and Strength of Sitka Spruce and Douglas Fir. By T. C. Scheffer and others. *Tech. Bull. No.* 779, *U.S. Dep. Agric.* Pp. 24, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 5 cents. The types of decay studied were those caused by *Fomes pini*, *F. laricis* and *Polyporus schweinitzii*.

A Preliminary Investigation of Blue Stain in "Kauvula" Timber. By J. L. Despeissis. *Agric. J. Fiji*, 1941, **12**, 37-40. This timber (derived from *Endospermum* spp.) is used locally for butter boxes.

Gums and Resins

Gum, Resinous and Mucilaginous Plants in East Africa. By P. J. Greenway. *E. Afr. Agric. J.*, 1941, **6**, 241-250. Scientific and commercial names of the plants are arranged in one list, and when available Swahili names have been given.

The Refining of Manila Copal. By S. S. Tanchico and A. P. West. *Philipp. J. Sci.*, 1940, **73**, 285-292.

Analysis and Composition of Manila Copal. By S. S. Tanchico and A. P. West. *Philipp. J. Sci.*, 1940, **73**, 259-282.

British Standard Specification for Lac. *Brit. Stand. No.* 954-1941. Pp. 32, 8½ × 5½. (London: British Standards Institution, 1941.) Price 2*s*.

Plasticising Lac Films. Part II. By G. D. Heath and B. S. Gidvani. *Tech. Pap. No.* 20, *Lond. Shellac Res. Bur.* Pp. 14, 8½ × 5½. (London: Shellac Research Bureau, 1941.)

Increased Naval Stores. Production from Chemically Treated Streaks. By T. A. Liefeld. *Occ. Pap. No.* 97, *Sth. For. Exp. Sta.* Pp. 6, 10½ × 8.

(New Orleans: Southern Forest Experiment Station, 1940.) Describes experiments designing to test the effect of chemical treatments on the yield of oleo-resin from longleaf pine and slash pine.

Composition of American Gum Turpentine Exclusive of the Pinenes. By T. C. Chadwick and S. Palkin. *Tech. Bull. No.* 749, *U.S. Dep. Agric.* Pp. 16, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 5 cents.

Tanning Materials

South African Wattle Bark and Wattle Extract with special reference to the American Market. Pp. 18, 9½ × 6. (Cape Town: Cape Times Ltd., 1941.) Prepared in the Office of the Director of Forestry. A review of the S. African wattle industry.

A Comparison of Wattle Growing in Natal and in Kenya. Part II. Kenya Conditions and Practice. By S. H. Wimbush. *E. Afr. Agric. J.*, 1941, **6**, 220-224.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 15

(April to June, 1941.)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

Insect Pests and their Control. *Agric. Gaz. N.S.W.*, 1940, **51**, Pt. 8, 434-438; Pt. 9, 516, 526. (*R.A.E.*, 1941, **29**, A, Pt. 5, 237; Pt. 6, 290.) General note on nicotine and pyrethrum dusts and sprays for controlling various insect pests attacking fruit trees and garden plants.

Insecticides and Fungicides. By H. B. S. Montgomery, M. H. Moore, H. Shaw and W. Steer. Report of the East Malling Research Station for 1939 (1940), pp. 32-34. (*R.A.E.*, 1941, **29**, A, Pt. 6, 281.) References to tests with nicotine, derris and pyrethrum against various pests.

Metallic Salts and Alkaloids in Agriculture. By R. Hutson. *Michigan Sta. Quart. Bull.*, 1940, **23**, No. 1, 46. (Abstract in *Exp. Sta. Rec.*, 1941, **84**, No. 2, 215.) General discussion on consumption of plant insecticides as affecting market for arsenicals.

Chemical Products for the Farm. Dips, Sprays, Medicines, Special Foods. By J. M. Vallance. *Mfg. Chem.*, 1941, **12**, No. 3, 52-55. Discusses generally various dips, sprays and dressings employing derris, nicotine, or pyrethrum.

Sanitary Products on the Poultry Farm. *Soap*, 1941, **17**, No. 5, 90-93, 109. Use of rotenone, pyrethrum and nicotine preparations against various poultry parasites.

Sanitation in Bomb Shelters. *Soap*, 1941, **17**, No. 3, 113. Note of measures taken by British Ministry of Health—both pyrethrum and derris recommended.

The Problem of Insect Vermin in Shelters. By J. R. Busvine. *Chemical Products*, 1941, **4**, Nos. 3-4, 35.

Report on (the Analysis of) Pyrethrum, Derris and Cube. By J. J. T. Graham. *J. Assoc. Off. Agric. Chem.*, 1940, **23**, 551-556. (*Amer. Chem. Abstr.*, 1941, **35**, No. 2, 574.)

Methods and Materials of a new Technique for using Pomace Flies in Biological Tests with Contact Insecticides. By H. T. Stultz. *Rep. Ent. Soc. Ontario for* 1939 (1940), **70**, pp. 72-80. (*R.A.E.*, 1941, **29**, A, Pt. 6, 311.)

Thirty-ninth Report of the Connecticut State Entomologist, 1939. *Connecticut Agric. Exp. Sta., Bull. No.* 434 (1940), 222-322. (*R.A.E.*, 1941, **29**, A, Pt. 4, 161.) Includes notes of experiments on the effect of strong sunlight on the activity of oil-impregnated rotenone dusts, and the control of various pests with nicotine, cube and derris dusts.

Über die Wirkungsart und -Dauer von Berührungsgiften. I. (On the Mode of Action and Length of Activity of Contact Poisons. I.) By O. Jancke and R. Roesler. *Z. Pflkrankh.*, 1940, **50**, Pt. 3-4, 134-142. (*R.A.E.*, 1941, **29**, A, Pt. 5, 232.) Nicotine, pyrethrum and derris studied. Derris dusts retained activity for a longer time after application than nicotine or pyrethrum dusts.

Effect of a Terpene Ether on Certain Fly Sprays. By R. L. Pierpont. *J. Econ. Ent.*, 1941, **34**, No. 2, 195.

Potassium Soaps of a Wood Rosin and Rosin Residues as Spreaders for Nicotine, Derris and Pyrethrum in Horticultural Sprays. By W. W. Fassig and R. L. Pierpont. *J. Econ. Ent.*, 1941, **34**, No. 2, 200.

How to Know and Control Stored-Grain Insects. By M. D. Farrar, T. F. Winburn and W. P. Flint. *Ill. Agric. Coll. Ext. Circ. No.* 512 (1941). (Abstract in *Exp. Sta. Rec.*, 1941, **84**, No. 5, 643.)

Insects affecting Greenhouse Plants. By A. Gibson and W. A. Ross. *Canada Dep. Agric. Publ.* 695 (1940). (Abstract in *Exp. Sta. Rec.*, 1941, **84**, No. 5, 642.)

Combinations of Insecticides for Control of Boll Weevil and Cotton Leaf Aphid. By C. F. Rainwater and F. F. Bondy. *J. Econ. Ent.*, 1941, **34**, No. 2, 297.

Further Studies of various Insecticides again three Cotton Insects. By G. L. Smith, A. L. Scales and R. C. Gaines. *J. Econ. Ent.*, 1941, **34**, No. 2, 310. Derris and pyrethrum tested.

Control of the Potato Flea Beetle on Shade-grown Tobacco in Connecticut. By A. W. Morril, Jun. *J. Econ. Ent.*, 1941, **34**, No. 2, 291. Cube, pyrethrum and tobacco dusts tested in comparison with silico-fluorides.

Observations on the Toxicity of some Insecticides as Stomach-poisons to Blowfly Maggots. By R. N. McCulloch. *J. Aust. Inst. Agric. Sci.*, 1940, **6**, No. 2, 105-108. (*R.A.E.*, 1941, **29**, B, Pt. 3, 49.) Nicotine sulphate and derris unpromising as substitutes for arsenites.

The Control of Fruit Tree Red Spider Mite. By H. G. H. Kearns and H. Martin. *Rep. Agric. Hort. Res. Sta. Bristol*, 1939 (1940), pp. 60-65. (*R.A.E.*, 1941, **29**, A, Pt. 3, 108-109.) Use of nicotine and rotenone sprays.

Field Control of the Gladiolus Thrips. By G. V. Johnson and F. F. Smith. *J. Econ. Ent.*, 1940, **33**, No. 3, 490-493. (*R.A.E.*, 1941, **29**, A, Pt. 4, 204.) Derris and nicotine proved inferior to spray of tartar emetic and brown sugar.

The Biology and Control of the Round-headed Apple-tree Borer, *Saperda candida* Fabr. By A. D. Hess. *N.Y. St. Agric. Exp. Sta., Bull.* No. 688 (1940). (*R.A.E.*, 1941, **29**, A, Pt. 5, 242-244.) Pyrethrum and rotenone preparations injected into the holes bored by the larvæ gave satisfactory results.

On the Bionomics of *Agromyza oryzella* Matsumura and Laboratory Tests of Some Insecticides against it. (In Japanese.) By K. Okazaki. *Ōyō-Kontyū, Tokyo*, 1940, **2**, No. 4, 148-161. (*R.A.E.*, 1941, **29**, A, Pt. 3, 98.) Nicotine sulphate, derris and pyrethrum sprays gave promising results against eggs and larvæ.

On the Life History of *Acanthocoris sordidus* Thun. By T. Yamazaki. (In Japanese.) *Ōyō-Dobuts Zasshi*, 1940, **12**, No. 2, 57-68. (*R.A.E.*, 1941, **29**, A, Pt. 4, 171.) Derris in soap solution or pyrethrum dust mixed with ash recommended as control measures.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Nicotine. By Miguel A. Manzano. *Rev. Agric., Ind. y Com., Puerto Rico*, 1940, **32**, 363-367. (*Amer. Chem. Abstr.*, 1941, **35**, No. 2, 581.) Distribution of nicotine in the tobacco plant, its extraction and use in the control of pests are reviewed.

Japan to increase Output of Nicotine Sulphate. *Oil, Paint, Drug Rep.*, 1941, **139**, 43. Note on annual consumption of nicotine sulphate by agricultural enterprises in Chosen and production from new factory operating there.

Distribution of Nicotine between Water and Petroleum Oils. By L. B. Norton. *Ind. Engng. Chem., Industr. Ed.*, 1940, **32**, No. 2, 241-244. (*R.A.E.*, 1941, **29**, A, Pt. 5, 245.)

Lamb and Hogget Drenching Trials in Canterbury, 1938-39. By H. E. Garrett. *N.Z. J. Sci. Tech.*, 1940, **22**, No. 2A, 110A-115A. Anthelmintic drenches containing 2 per cent. nicotine sulphate were used.

Nicotine Sulphate Dust for Control of Cotton Aphids. By A. L. Hamner. *Miss. Farm Research*, 1940, **3**, No. 7, 1. (Abstract in *Exp. Sta. Rec.*, 1940, **83**, No. 6, 798.) 5 per cent. nicotine sulphate dust effective.

Codling Moth Control. Report on 1938-39 Investigations. By K. M. Ward and J. L. Groom. *Queensld. Agric. J.*, 1940, **54**, Pt. 1, 17-37. (*R.A.E.*, 1941, **29**, A, Pt. 5, 238.) Good results from nicotine sulphate—white oil sprays.

Codling Moth Control. By D. O. Atherton. *Queensld. Agric. J.*, 1941, **55**, Pt. 3, 183-188. Various nicotine combinations suggested as cover sprays.

Insect Pests of Cabbages, Cauliflowers and Related Plants. By R. T. M. Prescott. *J. Dep. Agric., Vict.*, 1941, **39**, Pt. 3, 119-126. Nicotine sprays and dusts recommended for various pests.

Combined Derris-Nicotine Dusts for Cabbage Insects. By J. W. Brooks and T. C. Allen. *J. Econ. Ent.*, 1940, **33**, No. 2, 416-417. (*R.A.E.*, 1941, **29**, A, Pt. 3, 135.)

Red-legged Earth Mites. Their Occurrence and Control in New South Wales. By C. R. Wallace. *Agric. Gaz. N.S.W.*, 1940, **51**, Pt. 8, 431-433. (*R.A.E.*, 1941, **29**, A, Pt. 5, 236.) Good control from nicotine sulphate spray.

Experimental Spraying to Control European Red Mite (*Paratetranychus pilosus* C. & F.) and Rosy Apple Aphid (*Anuraphis roseus* Baker) in 1939. By H. N. Worthley and H. M. Steiner. *Pennsylvania Agric. Exp. Sta. Bull. No.* 390 (1940). (*R.A.E.*, 1941, **29**, A, Pt. 4, 191.) Addition of nicotine sulphate improved results from emulsion of Bordeaux mixture and lubricating oil.

Spraying for Grapeberry Moth Control. By R. Hutson. *Quart. Bull. Mich. Agric. Exp. Sta.*, 1940, **22**, No. 4, 263-265. (*R.A.E.*, 1941, **29**, A, Pt. 3, 117.) Nicotine sprays satisfactory in later sprayings.

Control of the Pea Aphid in Eastern Virginia in 1939. By H. G. Walker and L. D. Anderson. *J. Econ. Ent.*, 1940, **33**, No. 4, 620-623. (*R.A.E.*, 1941, **29**, A, Pt. 5, 249.) Tests with nicotine.

A Large Scale Test of Dusts to Control the European Corn Borer. By N. Turner. *J. Econ. Ent.*, 1941, **34**, No. 2, 284. Dual-fixed nicotine more effective than derris.

Summer Sprays for Control of the Gladiolus Thrips. By E. I. McDaniel. *Quart. Bull. Mich. Agric. Exp. Sta.*, 1940, **23**, No. 1, 8-9. (*R.A.E.*, 1941, **29**, A, Pt. 5, 277.) Gives composition of a nicotine spray to reduce infestation.

Control of the Leaf Roller, *Platynota flavedans* Clem. on Roses. By C. C. Hamilton. *J. Econ. Ent.*, 1940, **33**, No. 2, 364-368. (*R.A.E.*, 1941, **29**, A, Pt. 3, 132.) Pyrethrum sprays ineffective, regular fumigation with nicotine gave better results.

Other Alkaloid-containing Materials

A Review of Information on Anabasine. By R. C. Roark. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine*, E-537, 1941. (Abstract in *Soap*, 1941, **17**, No. 5, 109.)

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Report of the Puerto Rico Experiment Station, 1939 (1940). Investigations of Insecticidal Plants, pp. 71-83. A survey of resin- and starch-cell tissues in rotenone-bearing roots. Physiological investigation of effect of exhausting food reserves in roots of *Derris elliptica* and *Tephrosia toxicaria* on rotenone content and other extractives.

Report of Puerto Rico Experiment Station, 1939 (1940). Investigations on Insecticidal Plants, pp. 84-85. Iron-deficiency chlorosis in derris and lonchocarpus.

Rotenone in the Treatment of Scabies. A New, Non-odorous, Non-irritating Form of Treatment. Preliminary Report. By C. C. Thomas and E. E. Evelyn. *Amer. J. Med. Sci.*, 1940, **199**, 670-674. (Abstract in *Vet. Bull., Weybridge*, 1941, **11**, No. 1, 59.)

Rotenone in Low Concentration as a Tickicide and Insecticide for House Pets. By Z. de Jesus and R. P. Gapuz. *Philipp. J. Anim. Industr.*, 1940, **7**, No. 4, 391-395. (Abstract in *Exp. Sta. Rec.*, 1941, **84**, No. 5, 655.) Using cassava starch as a diluent effective results were obtained with concentrations of 1 and 2 per cent. rotenone.

Rotenone for Snowfleas. *Soap*, 1941, **17**, No. 5, 109. Brief note of effective control of snowfleas (*Collembola*) infesting cork insulation.

Derris

Report of the Puerto Rico Experiment Station, 1939 (1940). Investigations of Insecticidal Plants, pp. 85-86. High vegetative vigour of a clone of Derris from St. Croix. In comparative trials under adverse field conditions the St. Croix variety made more vigorous growth than Changi No. 3 and a larger number of the St. Croix plants became established.

Report of the Puerto Rico Experiment Station, 1939 (1940). Investigations of Insecticidal Plants, pp. 87-89. Manurial trials with derris.

A Note on Manuring Derris. *E. Afr. Agric. J.*, 1941, **6**, No. 4, 182.

Some Experiments on Staking Derris. By R. R. Le G. Worsley. *E. Afr. Agric. J.*, 1941, **6**, No. 4, 236.

Verslag over het jaar 1938 van Het Algemeen Landbouw Syndicaat, Batavia, 1939. (Report for the year 1938 of the General Agricultural Syndicate.) (*Pl. Breeding Abstr.*, 1941, **11**, No. 2, 92.) Reference to work at the Besoeki Experiment Station on the effects of cultural measures on the rotenone content of derris.

Leaf Spot of Derris. By P. R. Santos. *Philipp. Agric.*, 1941, **29**, 641-659. (*Hort. Abstr.*, 1941, **11**, No. 2, 139.) Account of disease, prevalent in the Philippines, with notes on attempted control measures.

Meded. Deli Proefst. 1940 (3), No. 7, Report of Zoological Section, by P. A. van der Laan, pp. 52-59. (*R.A.E.*, 1941, **29**, A, Pt. 6, 318.) Derris shown effective against certain capsids. Derris plantations attacked by a galerucid of the genus *Craniotetus*.

Cultivation of *Derris elliptica* in Guatemala. *Rev. Agric. Guatemala*, 1940, **17**, October, 320, and *Foreign Comm. Wkly.*, 1941, **2**, No. 3, 108. Notes on experimental plantings.

De rotenonbepaling in derrispoeders. Korte mededeeling van het Proefstation Midden- en Oost-Java, No. 26, *Bergcultures*, 1941, **15**, No. 14, 436. Note on determination of rotenone in derris powder.

Report of the Puerto Rico Experiment Station, 1939 (1940). Studies to Control Corn-Ear Pests, p. 59. Addition of derris powder to low strength pyrethrum mineral oil mixtures greatly increased their effectiveness.

Verdere gegevens omtrent de bestrijding van de Helopeltis door middel van derrispoeder. (Further Data concerning the Control of Helopeltis with Derris Powder.) By J. G. Betrem. *Bergcultures*, 1941, **15**, No. 9, 238-249. Information on strength and fineness of derris dust and times of application.

Derris Infusion as a Poultry Dip for Louse Eradication. By R. B. Gapuz. *Philipp. J. Anim. Industr.*, 1940, **7**, 153-162. (Abstracts in *Vet. Bull. Weybridge*, 1941, **11**, No. 4, 259 and *Exp. Sta. Rec.*, 1941, **84**, No. 4, 500.) Infusions in water of crushed fresh root of *Derris philippinensis* in proportion 1 : 100 or over were found to kill all kinds of chicken lice.

Derris Root in Scabies. *Chem. and Drugg.*, 1941, **134**, May 10, 293. Note from *Brit. Med. J.*, 1941, April 26, 624.

Preliminary Studies on the Comparative Value of some Sprays and Dusts in Potato Insect Control. By H. C. Manis and I. Leffert. *Iowa St. Coll. J. Sci.*, 1940, **14**, No. 2, 155-161. (*R.A.E.*, 1941, **29**, A, Pt. 6, 325.) Relatively good results from derris dusts.

Combined Derris-Nicotine Dusts for Cabbage Insects. By J. W. Brooks and T. C. Allen. *J. Econ. Ent.*, 1940, **33**, No. 2, 416-417. (*R.A.E.*, 1941, **29**, A, Pt. 3, 135.)

Notes on the Cabbage White Butterfly. *Vict. Nat.*, 1940, **57**, No. 5, 96-97. (*R.A.E.*, 1941, **29**, A, Pt. 6, 290.) Effective control with derris dusts, but nicotine dusts unsatisfactory.

Tests of Certain Insecticidal Dusts against the Striped Cucumber Beetle. By J. W. Brooks and T. C. Allen. *J. Econ. Ent.*, 1941, **34**, No. 2, 295. Derris dust most effective. Silicofluorides, arsenicals and nicotine also tried.

Notes on some Interesting Insects observed in 1939. By A. M. Massee. Report of the East Malling Research Station for 1939 (1940), pp. 70-73. (*R.A.E.*, 1941, **29**, A, Pt. 6, 282.) Derris dust effective against larvæ of *Argyroploce urticana* Hb. attacking strawberries.

Report of Progress for year ending June 30, 1939. *Maine Agric. Exp. Sta.*, No. 397 (1939), 695-846. (*R.A.E.*, 1941, **29**, A, Pt. 4, 164.) Reference to tests comparing calcium arsenate and derris dust for control of *Rhagoletis pomonella* Walsh on blueberries.

Fruit Tree Red Spider. Further Observations on the Pest and its Control. By G. L. Hey. *Fruitgrower*, 1940, **90**, Nos. 2335 and 2336, 196, 200, 219-220. (*R.A.E.*, 1941, **29**, A, Pt. 6, 286.) Suggested that derris with white oil may be as effective as white oil and nicotine against woolly aphis (*Eriosoma lanigerum*).

Lonchocarpus

Report of the Puerto Rico Experiment Station, 1939 (1940). Investigations of Insecticidal Plants, pp. 90-92. Selection in Lonchocarpus. Propagation of high rotenone-yielding clones by budding. Analysis of data indicates a large number of clones.

A Note on *Lonchocarpus nicou* dust for the Control of the Cabbage White Butterfly. By H. G. H. Kearns. Annual Report of the Agricultural and Horticultural Research Station, Long Ashton, Bristol, 1940, p. 80. Technique and cost of application outlined.

New Insecticides and Spreaders on Shade Trees. By E. P. Felt and S. W. Bromley. *J. Econ. Ent.*, 1940, **33**, No. 2, 247-249. (*R.A.E.*, 1941,

29, A, Pt. 3, 118.) Small-scale tests showed cube dust controlled very young larvæ of *Malacosoma americana* F.

An Outbreak of the Velvetbean Caterpillar in Alabama with Data on Control. By F. E. Guyton. *J. Econ. Ent.*, 1940, **33**, No. 4, 635-639. (*R.A.E.*, 1941, **29**, A, Pt. 5, 251.) Timbo dusts with 0·5 and 1 per cent. rotenone proved ineffective.

The Plum Cerculio Problem on Peach in Pennsylvania. By H. M. Steiner and H. N. Worthley. *J. Econ. Ent.*, 1941, **34**, No. 2, 249. Cube powder (5 per cent. rotenone) tested.

Others

Report of the Puerto Rico Experiment Station, 1939 (1940). Investigations of Insecticidal Plants, pp. 92-93. Specimens of *Piscidia piscipula* (originating from Jamaica) and a species of *Derris* gave positive results to the Durham test for rotenone. Further introductions of *Tephrosia toxicaria* low in rotenone and total extractives.

Report of the Puerto Rico Experiment Station, 1939 (1940). Entomological Investigations, p. 115. A new species of leaf miner (*Phyllonorycter*) reported attacking the leaves of *Tephrosia toxicaria* and *T. vogelii*.

Texas Agric. Expt. Sta., 52nd Annual Report, 1939. Studies in pollination of *Tephrosia virginiana* by bees.

Report of the Department of Agriculture, Uganda, for the year 1938-39 (1940). Report of the Entomologist, Kawanda, pp. 9-24. (*R.A.E.*, 1941, **29**, A, Pt. 5, 229-230.) Use of strong water extract of *Tephrosia vogelii* against Antestia attacking coffee proved completely inadequate.

PYRETHRIN-CONTAINING MATERIALS

Pyrethrum—Progress of an Empire Industry. By B. O'Donovan. *Planter and Tanganyika Advertiser*, 1941, **9**, No. 2, 18.

The Growing of Pyrethrum in India. By W. Burns. *Indian Farming*, 1941, **2**, No. 2, 58-60. (*Hort. Abstr.*, 1941, **11**, No. 2, 139.) Gives an account of trials made in different parts of India.

Progress Report on Forest Administration in Jammu and Kashmir for 1939, p. 21. Trial cultivation of *Pyrethrum cinerarifolium* in Baramulla.

Pyrethrin Content of Pyrethrum Grown in India. By J. K. Lahiri, S. Ghosh and R. N. Chopra. *J. Amer. Pharm. Assoc.*, 1941, **30**, No. 3, 72-73. Gives analyses of a number of samples from different areas.

Over-production of Pyrethrum in Kenya and Japanese Competition. *E. Afr. and Rhod.*, 1941, **17**, No. 869, 591.

Satisfactory Analysis of Pyrethrum Cultivated in Rhodesia. *E. Afr. and Rhod.*, 1941, **17**, No. 877, 720.

Pyrethrum Cultivation in Brazil. *Foreign Comm. Wkly.*, 1941, **3**, No. 6, 203.

Insecticidal Principal in Smoke from burning Insect Powder. III. By M. Nagasse. *J. Agric. Chem. Soc. Japan*, 1941, **17**, 6-10. (*Brit. Chem. Phys. Abstr.*, B, III, 1941, June, 146.) The smoke from burning pyrethrum contains acet-, prop- and isovaler-aldehydes, and butyric, isovaleric and an unknown acid.

Bioassay of Livestock Spray Using Hypnotic Doses Applied in a Spray Tunnel. By Craig Eagleson. *Soap*, 1941, **17**, No. 5, 101, 103, 105, 107. A new method of bioassay for pyrethrum sprays described and compared with methods previously used.

Agents for Increasing Toxicity of Pyrethrum to Mosquito Larvæ and Pupæ. By R. L. Mentzer, F. C. Daigh and W. A. Connell. *J. Econ. Ent.*, 1941, **34**, No. 2, 182.

Report of the Puerto Rico Experiment Station, 1939 (1940). Studies to Control Corn-Ear Pests, pp. 51-59. Pyrethrum extract with mineral oil gave good control. Effectiveness of low strength pyrethrum mineral oil mixtures greatly increased by addition of derris powder.

Antestia in the Northern Province of Tanganyika. By F. B. Notley. *E. Afr. Agric. J.*, 1941, **6**, No. 4, 194-198. Pyrethrum dust used for control.

Effect of Liquid Household Insecticides on the Oothecæ of the German Cockroach. By B. M. Parker. *Ohio State Univ. Abs. Docteral Diss.* 1940, No. 31, 257-264. (Abstract in *Exp. Sta. Rec.*, 1941, **84**, No. 4, 498.) Effect of pyrethrum and an organic thiocyanate examined.

Pyrethrum in Medicine. By W. K. Angevine. *Soap*, 1941, **17**, No. 3, 101, 103. Principally concerned with the effective control of external human parasites given by pyrethrum.

Utility of Pyrethrum as an Anthelmintic. By A. Jores and H. Wolter. *Klin. Wochschr.*, 1939, **18**, 885-889. (*Amer. Chem. Abstr.*, 1939, **33**, September, 7392.)

Control of Mosquito Nuisances. *Ministry of Health Memo. No.* 238 *Med.* (1941). (*Chem. and Drugg.*, 1941, **134**, June 14, 352.) Reference to use of pyrethrum-kerosene larvicide.

Preventive Measures against Mosquitoes. Part I. By G. R. Baxter. *Agric. J. Fiji*, 1941, **12**, No. 1, 16-18. Includes formula for anti-mosquito sprays containing pyrethrum, and refers to use of pyrethrum powder as a fumigant.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Ox-eye Daisy as Raw Material for Insecticide in Durban. *Chem. Age*, 1940, **43**, August 10, 69.

A Chinese Insecticidal Plant, *Tripterygium wilfordii*, introduced into the United States. By W. T. Swingle, H. L. Haller, E. H. Siegler and M. C. Swingle. *Science*, 1941, **93**, No. 2403, 60-61. (*R.A.E.*, 1941, **29**, A, Pt. 5, 241.)

Introduction of Selenium into Plant Tissues as a Toxicant for Insects and Mites. By C. R. Neiswander and V. H. Morris. *J. Econ. Ent.*, 1940, **33**, No. 3, 517-525. (*R.A.E.*, 1941, **29**, A, Pt. 4, 207.)

Toxicity of Selenium-containing Plants as a Means of Control for Red Spiders. By V. H. Morris, C. R. Neiswander and J. D. Sayre. *Plant Physiol.*, 1941, **16**, No. 1, 197-202. (*R.A.E.*, 1941, **29**, A, Pt. 5, 275.) The addition of selenium to water and sand cultures in quantities not injurious to the plants gave effective control of infestation.

The Control of Plum Fruit Sawfly (*Hoplocampa flava*). By J. H. Brair. *Agric. Bull., Palestine*, 1940, October-December, 165-166. Quassia-soap spray recommended.

CORRECTION.—In issue No. 12 of this Bibliography (this BULLETIN, 1940, **38**, No. 3, 448), under the section " General," the reference to the paper on the Relative Susceptibility of the Ootheca and Adult Female of the German Cockroach to Liquid Household Insecticides, by B. M. Parker and F. L. Campbell should read : " *J. Econ. Ent.*, 1940, **33**, No. 4, 610-614."

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

ECONOMIC GEOGRAPHY. A REGIONAL SURVEY. By R. H. Whitbeck and V. C. Finch. Fourth Edition. Pp. xii + 647, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1941.) Price 24*s.* 6*d.*

As is mentioned in the preface, the preparation of a fourth edition of this standard text-book has not been an easy task, for two reasons, first, the death of the senior author, Prof. R. H. Whitbeck, in July 1939, and second, the outbreak of war in Europe, just as the task was undertaken, which necessitated the rewriting of large parts of the text. The progress of the war during the period in which the book was undergoing revision further complicated the task and the junior author, Prof. V. C. Finch, is, therefore, to be particularly congratulated on the production of this excellent fourth edition, which is fully up to the high standard of the previous editions.

Apart from an introductory chapter, the first seventeen chapters deal with the United States and Canada, and, as the author points out, the conditions of environment, the people and the economic life of certain sections of the two countries are so similar that they are best treated as one unit at many points in these chapters. Chapter XVII, however, is a summary chapter dealing with Canada as a whole. As a majority of the most important commodities of commerce are produced in the United States, the author has included detailed chapters on many of them, such as Grain and Forage Crops, Vegetable Crops, Fruit Crops, Sugar, Vegetable Oils and Tobacco, Vegetable Fibres, Forests and Forest Products, etc., in the section devoted to the United States, while other commodities, such as Silk, Rubber, Coffee and Tea, receive detailed treatment in the chapters relating to those countries in which they are important.

Part II, Chapters XVIII to XXXIII, deals with the world outside of the United States and Canada on a regional basis. There is also an appendix giving statistics as to area, population, trade, etc., of the various countries. The book contains many excellent photographs and illustrations, and at the end of each chapter a selected list of references to further literature is given.

This up-to-date book will be found invaluable by all students and teachers of Economic Geography.

ECONOMICS WITH APPLICATIONS TO AGRICULTURE. By Edwin F. Dummeier, Ph.D., and Richard B. Heflebower, Ph.D. Second Edition. Pp. xii + 752, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 26*s.*

This work, now in a second edition, has been written as a text-book for use in colleges in the United States on economic principles

with particular reference to the application of these principles to agriculture. The book provides a wide and comprehensive survey of the subject, and may be employed to form the basis of elementary or more advanced courses of study. Each of the thirty chapters of which it is composed is supported by a list of questions and problems to test the student's grasp of the matter, and also by a selected bibliography of authoritative works on the particular questions discussed to provide for further study.

A work such as this naturally has a somewhat limited scope outside the country with reference to the economic circumstances of which it has been particularly written, but it nevertheless provides the student elsewhere with much general information concerning American agricultural economic developments that should be of value.

SOILS AND SOIL MANAGEMENT. By A. F. Gustafson. Pp. viii + 424, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1941.) Price 21*s*.

This volume is written mainly for the use of the American student to provide a textbook on practical soil management, but it is also hoped that it will find a use in the wider field among those concerned with the ownership or utilisation of land. As the writer claims in his preface, soil management and the various aspects of manuring are dealt with in detail, but it has only been possible to give an outline of the important subject of soil conservation. The author deals not only with the scientific problems relating to the soil, such as physical properties, soil organisms, humus, the functions of fertilisers and so on, but also with such essentially practical questions as drainage and irrigation, tillage and rotation of crops.

Professor Gustafson is to be congratulated on having produced a practical and very readable account of his subject. Certainly this book should appeal to the wide public interested in farming in the United States, and a knowledge of the principles laid down should help to prevent many errors in land management.

The work is provided with some excellent illustrations and contains many tables, while frequent references to literature occur as footnotes in the text.

HUNGER SIGNS IN CROPS. A Symposium. Edited by Gove Hambidge. Pp. xiii + 327, 10 × 7. (Washington, D.C.: The American Society of Agronomy and The National Fertiliser Association, 1941.) Price $2.50.

When agricultural research and experiment along any line have progressed to a practically useful stage the work must be carried one step further in passing on to the grower the knowledge gained, so that its lessons may be applied in general farming practice. It is just this step between the experiment station and the farmer

that *Hunger Signs in Crops* is designed to fill, by giving a concise account of the deficiency symptons of the more important food crops. It is intended that this account, based on data collected from extensive experimental work, should enable the farmer to recognise for himself in many cases the cause of nutritional disorders in his crops and to take measures to correct them.

After a brief introduction the subject matter is presented in eight chapters, contributed for the most part by members of the staffs of experiment stations taking part in the original investigation work, and dealing in turn with the nutrient deficiencies of different crops and groups of crops. The crops considered are: tobacco, corn (maize) and small grains, the potato, cotton, vegetables and market garden crops, deciduous fruits, legumes and citrus. Within the chapters the symptoms are discussed under the headings of the different elements concerned, and in some cases keys are given to assist in the diagnosis, and chemical tissue tests are described as a means of confirming suspected deficiencies. The text is well illustrated with numerous excellent photographs, mostly coloured, which must prove an extremely valuable aid to recognising the conditions described.

It is inevitable that some crops should receive a more detailed treatment than others in which experimental work has not progressed so far. No claim is made for the book as a final word on the subject; it simply represents a summary of the data so far available, put into a form that the non-technical man can understand, and as such it is an excellent piece of work.

THE DISEASES OF THE COCONUT PALM. By H. R. Briton-Jones, D.Sc., Ph.D., D.I.C., A.R.C.S. Revised by E. E. Cheesman, M.Sc., A.R.C.S. Pp. xvi + 176, $8\frac{3}{4} \times 6\frac{3}{4}$. (London: Baillière, Tindall & Cox, 1940.) Price 10*s*. 6*d*.

The manuscript of this book was completed shortly before the author's death in November 1936, but as publication was delayed the text has been revised and brought up to date by Professor Cheesman.

The book is not an academic treatise, but takes the form of a straightforward account of what is known of the various diseases of the coconut palm, their symptoms and control, and is intended primarily for growers and agricultural officers with limited library and research facilities. The text, which is illustrated with numerous photographs, is in ten chapters dealing with the " bud rot " complex, bronze leaf wilt, *Phytophthora* bud rot, tapering stem wilt or pencil point disease, red ring disease, false wilt and lightning strike, the stem-bleeding disease, root diseases, leaf diseases and finally gumming disease and dropping of nuts.

The subject of the book is one to which much attention has been devoted (as the 17-page bibliography concluding the text will

testify), and in some cases the conclusions of different workers have been at variance. It is on this account all the more valuable that the judgment of the author in presenting his subject matter is based on long personal experience and study of the problems concerned.

In bringing the text up to date Professor Cheesman has added notes on some important papers that have appeared since the author's death, while in the chapter on bronze leaf wilt some rearrangement of the sequence was desirable in the light of recent work.

TECHNOLOGY FOR SUGAR REFINERY WORKERS. By Oliver Lyle. Pp. 401, 9 × 6. (London: Chapman and Hall, Ltd., 1941.) Price 15*s*.

The writer of this book has made a valuable contribution to sugar literature, and has, moreover, provided a work which is somewhat outside the common run of technical publications. It has been written primarily for the Plaistow Wharf staff of Messrs. Tate & Lyle, but should be widely appreciated by all who wish to have some insight into the processes involved in the refining of raw sugar. The purpose of the work is to explain the various processes employed in sugar refining with the object of making these processes clear to workers in the industry; it does not profess to be a standard textbook on sugar refining.

The work provides a comprehensive account of the various steps in the refining of sugar, and useful descriptions are given of the methods employed, together with particulars of the plant used. Throughout the text the author is careful to explain how the refinery plant works and why particular items of equipment are used. The applications of heat and electricity in the refinery and the various tests necessary are also described.

The book is written in an informal style which suits the author's primary object, and it is very readable though naturally many of the more technical descriptions require a little understanding. Based as this volume is on the writer's intimate industrial knowledge and experience it is a highly authoritative work. There are a number of excellent illustrations and a useful index is provided. Altogether the author and publishers are to be congratulated on the appearance and form of this book. Perhaps its publication may stimulate similar works written with respect to other industries, which if the standard set by Mr. Lyle's book were maintained would be very welcome.

MANUAL OF CULTIVATED TREES AND SHRUBS HARDY IN NORTH AMERICA. By Alfred Rehder. Second Edition, revised and enlarged. Pp. xxx + 996, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: The Macmillan Company; London: Macmillan & Co., Ltd., 1940.) Price 42*s*.

The appearance of a revised and enlarged edition of a standard botanical reference book such as this manual is always welcome.

The author, who is Associate Professor of Dendrology and Curator of the Herbarium, Arnold Arboretum, Harvard University, is a widely recognised authority on the trees and shrubs of North America. Naturally this publication must make its widest appeal within the North American continent, but the information contained in its thousand pages is of value to all concerned in the growing of woody plants, no less than to botanical workers and students everywhere.

The work provides an enumeration of the cultivated trees and shrubs of temperate North America, the warm-temperate and sub-tropical regions are excluded. Over 2,550 species are fully described and in addition briefer reference is made to all the more important varieties. To facilitate identification keys are provided to the families and genera. It is a volume that should be available in the libraries of all scientific institutions concerned with plant industry.

FARM ANIMALS. THEIR BREEDING, GROWTH AND INHERITANCE. By John Hammond, M.A., D.Sc., F.R.S. Pp. viii + 199, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Edward Arnold & Co., 1940.) Price 14s.

This useful volume is based on two series of lectures given by the author at the Universities of Leeds and London. It is divided into two parts entitled: Fertility and Growth in Farm Animals, and Genetics in Relation to the Practical Problems of Breeding Farm Animals. In the first part separate chapters are devoted to the breeding of horses, cattle, sheep, pigs and poultry. These are followed in the latter half by discussion of Mendelian applications, evolution and selection, inbreeding and cross-breeding, and breeding for production. The work, which does not pretend to be more than an introduction to the subject, is well illustrated by diagrams and figures, and each chapter is followed by a comprehensive list of references from which more details can be obtained.

As the author points out in introducing the second part of the book, progress in animal breeding depends to an appreciable extent on what is achieved by individual farmers, in contrast to plant breeding which is mainly the concern of the specialist. Thus an authoritative work such as this which should appeal to the practical breeder is always welcome, and it should prove of considerable value in British overseas countries where livestock improvement is receiving attention.

ENTOMOPHAGOUS INSECTS. By Curtis P. Clausen. Pp. x + 688, 9×6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 49s.

The object of this authoritative book is to collect together the very extensive information available on the subject of entomophagous, parasitic and predatory insects so that it will be readily

available to the worker and to the student who have normally access only to a limited number of original publications. The author, moreover, has endeavoured to present the subject matter as nearly as possible in the form in which he himself would like to have it available while engaged in field work upon insect parasitology and the biological control of insect pests.

The work is a very comprehensive study ; consideration of the Hymenoptera occupies approximately half its length, while over a hundred pages are devoted to the Diptera. The volume is well illustrated and the list of references cited in the text covers 47 pages.

ELEMENTS OF BOTANICAL MICROTECHNIQUE. By John E. Sass, Ph.D. Pp. ix + 222, 9 × 6. (London : McGraw-Hill Publishing Co., Ltd., 1940.) Price 17*s.* 6*d.*

Written with the object of providing a training manual in the science of microtechnique to meet the needs of teachers, this volume is based on a course in histological methods given by the author at the Iowa State College. The first portion of the work, which is divided into two parts, is devoted to the collection, preparation, sectioning and staining of plant material and embedding processes using both paraffin and celloidin (collodion). In later chapters the sectioning of unembedded tissues and the preservation and mounting of material are described. In the latter half of the textbook detailed directions are given regarding the treatment of specific subjects, and the concluding pages deal with the construction, use, and care of the microscope and with micro-photography.

The work embodies much information and many suggestions based on the writers' own experience and possesses the merit, in a book for beginners, of not obscuring the essential facts by too much detail. It is well illustrated with figures, to which frequent numbered references are made in the text, contains many formulæ, and is completed by a short bibliography. It can be recommended as an excellent introduction to this important subject.

MINERAL RESOURCES

ARTICLE

GOVERNMENT ASSISTANCE TO THE EMPIRE MINING INDUSTRY

INTRODUCTION

THE extent to which the various Governments of the Empire assist their mining industries in one way or another is not generally realised or appreciated. An attempt has consequently been made in the following pages to review the position in all the Empire countries overseas where mining is carried on, so that miners and administrators may be better able to assess what is done to aid the industry, not only in their own country but in other parts of the Empire, and to compare the different schemes in operation. The literature bearing on this subject is very scattered, and the present statement, though comprehensive, is greatly abbreviated and does not claim to be complete.

The ways and means by which help is afforded to prospectors and miners in the Empire overseas naturally vary widely in different countries. For the most part, assistance is provided through the media of the Geological Surveys and Mines Departments where these exist, and the amount is usually proportional to the state of development of the country. Thus the help provided in the Dominions which have highly developed mining industries is much more abundant than in the Colonies; Canada and the Union of South Africa, for instance, in addition to financing the ordinary work of the Geological Surveys and Mines Departments, maintain extensive laboratories in which problems of ore dressing and the preparation of minerals for the market are investigated in detail.

In the Colonies and Mandated Territories the Mines Department, where one exists, is usually concerned with matters affecting the issue of prospecting licences and mining leases, as well as the observance by mining concerns of the regulations made under a Mining Ordinance for safety and health and the adequate beaconing of mining or prospecting concessions. On the other hand, assistance and advice to prospectors on the economic aspect of their discoveries is usually given by officers of the respective Geological Surveys. It is usually assumed, however, that the primary duty of the Geological Survey Department is the production of a geological map of the country and the detailed geological mapping of areas in which deposits of economic minerals are known to occur or in which their

existence is suspected. Nevertheless the extent to which any particular Geological Survey concerns itself with the search for and development of deposits of useful minerals has in the past depended in some measure upon the economic, as distinct from the academic, outlook of the directing staff concerned.

The assistance given by Governments does not stop at merely giving advice to prospectors concerning the most suitable areas for examination ; in most cases advice is available on the nature and quality of the minerals discovered and on the most suitable methods of working them and marketing the products, while further assistance is sometimes provided in such forms as the temporary remission of mining rents and royalties, grants of free title to claims as a reward for first discoveries of certain minerals, a bonus or bounty on production, the loan of drilling equipment for prospecting, the provision of State concentrating plant or smelters, and even in certain cases direct financial aid in some form or other.

The question of Government financial aid to the mining industry comes to the fore where the deposits are not large enough to attract company enterprises, but where they offer opportunities for small-scale operations by individuals or small syndicates. The small reef worker is often handicapped, especially in the initial stages, by being unable to find enough capital, first, to test his property adequately, and second, to procure an efficient mill with which to recover the gold profitably. The policy of " grubstaking" has been tried in a number of parts of the Empire (notably in Australia), and whilst this has sometimes yielded good results, in general it has been found unsatisfactory, particularly in view of the abuses to which such a system is open.

The need for intensive geological investigation and for assistance to prospectors is less urgent in areas where large concerns, employing their own geologists and with large financial resources, are operating, e.g. Northern Rhodesia and Borneo. In some countries the large companies do detailed work on restricted areas leaving questions of the general geology of the country to the Survey, e.g. Gold Coast. Where large-scale payable deposits are located the question of Government assistance rarely arises as adequate financial backing is available for their exploitation.

Northern Rhodesia furnishes an instance of a private syndicate playing a major part in providing the country with a Geological Survey in the course of its prospecting activities.

Certain countries of the Empire have no established Geological Survey. These are principally the smaller units that do not warrant a permanent organisation. In many of these a temporary geologist has either been appointed for a specified period (e.g. Somaliland, Falkland Islands) or has been seconded from another survey (e.g. The Gambia). It was generally previously known from the visits of unofficial geologists, travellers, etc., that there was little possibility of the occurrence of economic minerals in these places and the

appointment of a temporary geologist has resulted in little more than official confirmation of the lack of economic possibilities and the issue of an official report to that effect.

Native Protectorates are governed essentially in the interests of the native, and prospecting is often discouraged even though the increase in wealth which would result from the exploitation of mineral resources would benefit the indigenous population (e.g. Basutoland). In Bechuanaland, however, the policy of the Government as contained in the Mines and Minerals Proclamation of 1932 is definitely to encourage prospecting, but the interests of both the natives and the Government are closely watched. Nevertheless no specific Government aid towards furthering mineral development has been granted in the Protectorate hitherto, for here again the large mining finance houses have the necessary organisation for undertaking the whole of any prospecting and development in promising areas.

One form of assistance which is available to all Government Departments, companies and private individuals in the Empire is that provided by the Imperial Institute which is maintained by contributions from the Dominions and Colonies and by a vote from the United Kingdom Treasury. The services available can be briefly summarised under two headings:

(1) *Laboratory Work.* The identification, analysis and where necessary small-scale technical trials of samples forwarded for report as to their commercial possibilities.

(2) *Intelligence.* The collection, correlation and dissemination of information relating to the occurrence, utilisation and marketing of all minerals throughout the world.

It is natural that the laboratory service is less utilised by the Dominions, which are usually well-equipped in this direction, than by the Colonies and Mandated Territories whose technical staffing is on a much smaller scale. The intelligence service, however, with its numerous publications is utilised by all countries of the Empire.

Australia

In the Commonwealth of Australia and the neighbouring territories of Papua, New Guinea, Norfolk Island and Nauru, assistance is given to the mining industry, not only under the provisions of various Acts of the Commonwealth Government, but also by means of a considerable number of different schemes in operation in individual States.

Each major division or State has either its own Geological Survey or Mines Department or both, through which advice is given regarding suitable areas for exploitation and means of development; advances may be made in certain cases for the purchase and erection of mining plant and machinery, and rewards may be made for mineral finds. The Government of the Commonwealth has rendered considerable financial assistance to the industry under the provisions

of a series of Acts such as the Precious Metals Prospecting Act of 1926, the Gold Bounty Act of 1930, the Petroleum Oil Search Acts of 1936 (which superseded the Petroleum Prospecting Acts of 1926, 1927 and 1928), the Loan Appropriation (Unemployment Relief) Act of 1934, the Northern Australia Survey Act of 1934 and the Sulphur Bounty Act of 1939.

The Precious Metals Prospecting Act, 1926, provided a sum of £40,000, of which £15,000 was to be expended in the Northern Territory, the balance to be allocated to the States in such proportions as the Minister determined. The total expenditure under this Act has amounted to £27,000, but no further assistance is contemplated from this fund.

The Gold Bounty Act, 1930, provided that for a period of ten years from January 1, 1931, a bounty of £1 per oz. would be payable under prescribed conditions by the Commonwealth on each oz. of fine gold produced in excess of the average production for the three years 1928-30. Under the Financial Emergency Act, 1931, the Bounty was reduced to 10*s*. per oz., subject to increases of 1*s*. for each decrease of 3*s*. per cent. in the average rate of exchange. The rate of exchange on which the reduction to 10*s*. per oz. was based was taken as 30 per cent. Under the Financial Emergency Act of 1932 the bounty was temporarily suspended.

Under the Loan Appropriation (Unemployment Relief) Act, 1934, a sum of £283,750 was made available to the States as grants for assistance to metalliferous mining. In addition a further sum of £210,000 was made available during the two years ended June 1938 for the same purpose. The total amount of assistance granted by the Commonwealth Government was £543,750, distributed among the States and Territories as follows: New South Wales, £75,700; Victoria, £95,700; Queensland, £130,500; South Australia, £46,300; Western Australia, £106,400; Tasmania, £39,150; Northern Territory, £45,000; and Papua, £5,000.

The Sulphur Bounty Act of 1939, which came into operation on October 24 of that year, provides for a bounty on the production of sulphur for five years. The bounty is on a sliding scale adjusted to a basic rate of £1 7*s*. 0*d*. per ton, while the maximum is £1 16*s*. 0*d*. per ton. It is hoped that this bounty will, *inter alia*, bring about an increased production of pyrites and will justify the erection of plant for the recovery of elemental sulphur.

New South Wales.—The Geological Survey of this State is a branch of the Department of Mines and is chiefly concerned with detailed geological surveys of mineral areas, with water resources, and with the examination of applications for aid to prospecting, which is granted through a Prospecting Board.

The chief aid given by the State Government has been in the assistance to prospectors, but there were no appropriations from the Prospecting Vote for the three years ended 1937-38; all claims are met from Unemployment Relief Funds and the Commonwealth

Grant. Aid is granted on a footage basis to sink, drive, etc., on approved sites to which a valid mining title is held. Loans are also made to assist in the erection of crushing batteries or reduction plants on which interest at the rate of 4 per cent. is charged. During 1938 loans totalling £10,087 were approved.

Rewards for the discovery of new mining fields in the State which had been offered for a number of years past were withdrawn in 1938.

The State maintains an Experimental Treatment Plant at the Mining Museum where problems concerning the best method of treating refractory ores, usually of gold or tin, are dealt with.

In 1935 £75,700 was provided by the Commonwealth Government for encouraging prospecting and mining generally and of this £44,000 was allocated for footage aid; £9,300 as loans for erection of machinery, etc.; £5,000 as ration allowance to unemployed coal miners whilst prospecting; £15,800 for geological, aerial and geophysical surveys and engagement of technical staff; £500 for metallurgical investigation; £500 for constructing roads of access to mines; and £600 for educating miners.

Victoria.—Assistance to mining in Victoria is provided in various ways by the Department of Mines, which includes the Geological Survey. Thus the Director and staff of the Geological Survey are available to give free advice on all mining matters; maps, plans and literature on different aspects of mining are supplied either free or at a nominal charge, and specimens are investigated or assayed free for *bona fide* prospectors and in other cases at low rates. Provision is made at State batteries (26 being operated by the Mines Department and six by local trusts) for cheap crushing facilities, including concession rates to *bona fide* prospectors on account of low yields or long cartage. Plant such as hand and power boring plants and pumping outfits may also be loaned at nominal rentals.

Since 1931 assistance to 17,072 unemployed men has been given by the free issue of prospecting equipment, a copy of the Prospector's Guide and a railway ticket to an approved locality. At least one member of any party must be an experienced miner. Men on sustenance can receive payments at the centre nearest to the locality in which they are prospecting.

Mining grants from the Unemployment Relief Fund are available to parties of two or more men holding a registered claim and carrying out an approved programme of development work. Allowances of £1 per week for each member of the party may be granted and ropes and explosives may also be provided. Since June 1930 6,421 advances have been made under this scheme to individual miners, parties and syndicates.

A third scheme, carried out with the joint assistance of the State and Commonwealth Governments, provides for financial aid in mining development for holders of mining leases (including syndicates and companies) by which an advance is made without interest

on a £1 to £1 basis from the fund thus established. Allotments from this fund to the end of 1938 totalled £76,000, of which amount £66,068 had been actually expended.

Up to the end of 1938 £116,015 has been expended in assistance to mining. Of this amount £33,034 was provided by the State and a like sum by the Commonwealth as subsidies or advances to mining companies. The remainder was provided by the Commonwealth and includes £18,132 for prospecting, £17,000 for technical and administrative staff, £5,210 for plants on loan, £2,832 for roads and tracks, £2,365 for education of miners and £4,408 for various other purposes.

The Victorian Government has always been sympathetic to the search for oil and has spent large amounts of money in exploratory drilling, the present Government alone having expended £11,500 since 1935 and the Commonwealth Government a like amount. Recent legislation has also been designed to facilitate the discovery and exploitation of oil.

Queensland.—Geological work has been carried out officially since 1853 and in 1879 a geological survey was established. The work, however, was principally that of a mineral survey.

A Royal Commission on the mining industry of Queensland (1930) drew attention to the decline in the industry in the preceding 10 years and to the stimulus which good, sound geological work is capable of giving to mining. It was recommended that assistance to mining should take the form of advice on improved methods of mining and metallurgy; a sympathetic policy on the part of the Government with regard to law, labour, taxation, etc.; and the finding of new deposits by the Geological Survey Branch of the Mines Department.

The survey functioned chiefly in an advisory capacity on routine matters, on applications for guidance and financial assistance, on departmental and private drilling on various gold and mineral fields, on petroleum exploration including shallow and deep drilling, on the iron ore search, on the development of the State mineral resources, on juvenile employment in prospecting, on coal beneficiation and on the utilisation of coal in liquid fuel production.

State assistance to the mining industry during 1937-38 amounted to £52,574, of which £50,743 was advanced to prospectors, the balance, consisting of grants under the Mining Machinery Advances Act, having been spent on the provision of transport facilities, etc., to mineral fields. In addition £9,987 was spent in connection with the aerial survey of North Australia.

The Chillagoe State Smelters treated 22,498 tons of gold, copper and lead ores and recovered 16,563 oz. gold, 1,906 tons copper, 40,954 oz. silver during the year. The copper furnace treated 24,838 tons ore for the recovery of 2,136 tons blister copper, 16,687 oz. gold and 41,991 oz. silver.

The Irvingbank State Treatment Works operated a concentration

plant for treating tin and wolfram ores. The tonnage of tin ore treated for the public in 1938 was 3,942 tons for the production of 156 tons of concentrates valued at £22,178. Wolfram ore treated was 75 tons giving 3 tons of concentrates. The tin-wolfram ore treated was 140 tons giving 5 tons of tin and 1 ton of wolfram.

Small quantities of tin-wolfram-bismuth ore and gold-bismuth ore were also treated. The State Battery at Kidston treated 9,229 tons of ore during 1938 for a yield of 1,585 oz. of retorted gold, while the Venus Battery at Charters Towers was working under lease and recovered 2,934 oz. of bullion from 6,130 tons of ore.

South Australia.—Aid is given to the mining industry under the terms of the Mining Acts of 1930 and 1931. Up to the end of 1937 the total amount of subsidy paid was £70,915, of which £16,796 has been repaid, and £4,700 written off, leaving a debit of £49,419. Part of this amount is represented by machinery that has fallen into the hands of the Government. Repayments must be provided from profits, but in only two instances have the profits enabled a full return to be made. The State maintains batteries and cyanide works at Mount Torrens, Peterborough, Mongolata, Tarcoola and Glenloth, and assays for public purposes are made at the School of Mines. Advances to prospectors in 1937 amounted to £3,767.

In 1939 the State Government announced that in view of the great demand for copper, assistance would be given to help in opening up old copper mines which had been productive in the past.

The assistance will take the form of financial help towards such development work as is absolutely necessary to enable the mine to enter upon reasonably continuous production, but the premature erection of treatment plants of any kind is deprecated.

There are still available for development work funds which have been contributed in equal amounts by the Commonwealth and State Governments to assist metalliferous mining. Among the conditions it is laid down that the recipient of any advance must provide an amount equal to the sum allocated from the fund either in the form of working capital or its equivalent in labour.

The Gold Mining Encouragement Acts (1940) made provision for the distribution of £1,000 which the Commonwealth Government made available to foster the production of gold. The State Government has decided to distribute the funds on a tonnage basis to the producers who forward ore to Government batteries and cyanide works for treatment. Advances of 3*s.* and 2*s.* will be made according to the plant at which the ore is treated so that the largest advance is available to producers who utilise plants where a higher rate is charged. Advances of 1*s.* per ton of ore are allowed in the case of those parcels on which the special concession is claimed for low-grade ore valued at less than 25*s.* per ton. The Act also makes provision for the refund of gold tax to *bona fide* prospectors and other producers whose operations might be rendered unprofitable by reason of the tax.

Western Australia.—The mining industry of Western Australia

is given official assistance by means of the State Mining Engineer, the Superintendent of State Batteries, the Government Geologist, the Director of the Kalgoorlie School of Mines, the Chief Inspector of Machinery, the Government Mineralogist and Analyst, the Chief Inspector of Explosives, and the Department of Mining Statistics. Annual progress reports are submitted to the Minister of Mines and are published conjointly in the Annual Report of the Department of Mines, Western Australia.

In 1922 the Geological Survey was amalgamated with the Government Analytical Department. The activities of the Geological Survey include investigations on problems of economic geology and of water supply for mining operations as well as for agricultural and pastoral pursuits. The Department also collaborates with Queensland in the aerial, geological and geophysical survey of Northern Australia.

The State maintains a school of mines at Kalgoorlie, which carries out free assays and mineral determinations as well as investigations on metallurgical problems.

Western Australia maintains State batteries for the treatment of gold and tin ores mined by private concerns and individuals. In 1938 24 such batteries were in use, and the amount of gold ore treated was nearly 109,000 tons. As a rule the State batteries show a small profit—£11,622 in 1938.

The mining industry of Western Australia is further assisted by the Mining Development Act of 1902, under which the following sums *inter alia* were expended during 1938: £5,210 advanced in aid of mining work and equipment of mines with machinery; £1,140 as subsidies on stone crushed for the public; £15,283 for providing means of transport, equipment and sustenance to prospectors; and £283 for various other forms of assistance.

Northern Territory.—An Aerial, Geological and Geophysical Survey was inaugurated in 1935 by the Governments of the Commonwealth, Queensland and Western Australia with the object of seeking new mineral resources in Northern Australia. It was the original intention to devote three years to this work, but the period was extended and the field programme has only recently been concluded.

The most modern scientific methods were utilised and the resources of the Royal Australian Air Force were made available to the Survey. The Air Force carried out aerial photography and reconnaissance flights and assisted in the transport of officers.

Some idea of the magnitude of the work may be gathered from the fact that the territory from which areas had to be selected for geological and geophysical examination occupies more than 1,000,000 sq. miles, stretching right across Northern Australia from east to west. Rapid transport is an essential factor in such a large territory.

During the period up to June 30, 1939, a sum of £187,269 was expended by the Survey, much of which was devoted to the employment of leading scientists, including geologists and geophysicists.

The Government maintains State batteries at Maranboy, Pine

Creek and Tennant Creek. Government assayers make free assays for prospectors and arrange for sampling, storage and sale of ores.

During the year ended June 30, 1939, assistance in the form of rations and equipment to miners and prospectors amounted to £924, while subsidies to the extent of £2,846 were granted to mine owners and companies for mine development and the purchase of machinery. Further sums were expended on diamond drilling and prospecting at Maranboy. The total amount expended for all the purposes mentioned was £4,766.

Tasmania.—The mining industry of Tasmania is granted official assistance in a number of ways. Not only are geological surveys, geophysical prospecting and drilling carried out for the benefit of the mining industry, but advice is given on metallurgical problems; relevant publications, maps and reports are issued, and financial assistance is given to prospectors.

Assistance to mining may be granted in several forms under the Assistance to Mining Act of 1927. This may take the form of sustenance grants to prospectors up to a maximum of £2 10*s*. per week for individual prospectors and half that rate for men employed by companies, provided that in the latter case the concern puts up an equal amount. Grants may also be made for testing and proving a discovery; either as loans to lessees, tributors, or prospectors, or the Governor may cause the work to be undertaken by persons employed by the Government. The work may include testing, drilling, prospecting, surveying, or mining.

During 1938 a number of grants were made under the Act for the development of claims, provision of plant, water supply and other incidental matters. The total amount authorised was £3,800 giving employment to about 150 men. Repayments totalled £1,720. The total value of the ore raised by those assisted amounted to £20,000.

New Guinea and Papua.—Shortly after the war of 1914-18 geologists were seconded from Australia to investigate questions of general and economic geology, but the bulk of the prospecting which led to the discovery of the gold deposits was done by private individuals, the development on a large scale being later carried out by mining companies. The administrations of the two countries give *bona fide* prospectors and companies every encouragement.

In New Guinea an Administration Geologist and an Assistant form part of the mines section of the Department of Lands, Surveys, Mines and Forests.

Prospecting for oil has for some years engaged the attention of private companies and of the Australian Government on whose behalf a certain amount of the prospecting has been carried out.

The Rabaul Museum includes a mineral collection.

Burma

The general welfare and safety of miners in Burma as well as the effective management of mining operations are directed by the

Mines Inspectorate working under the general surveillance of the Chief Inspector of Factories, Mines and Explosives. The Inspectorate administers the Mines Act, Burma (1937), which, apart from questions of safety, does not regulate the development of mining properties. Prior to the Separation of Burma, expert attention to domestic mining matters was provided only by short periodic visits of officers of the Indian Mines Department.

The Burma Geological Department, the successor to the Burma Circle of the Geological Survey of India, commenced to function as a separate entity on April 1, 1937. The main duties of the Department are: to carry out a geological survey of Burma; to inspect the working of mineral concessions with a view to seeing that the mineral resources of the country are being properly developed; and to advise Government on the terms on which concessions should be granted. The present department includes three officers on foreign service from the Geological Survey of India, which has agreed to provide officers to man the Department from April 1, 1937, for a period of five years in the first instance. The Department has a library and a chemical laboratory. The library is open to the general public and specimens are qualitatively examined and identified by the department free, provided the localities from which they have been obtained are notified. Advice is also given to prospectors on request by any officer of the department in the field or on application to the headquarters.

Individual small miners are catered for under the Upper Burma Ruby Regulation (precious and semi-precious stones), the Kyaukpyu and the Minbu, Pakokku, Lower Chindwin and Thayetmyo Districts Petty Oil Winning Leases and the Mergui Tin Mining Rules.

Canada

The Canadian mining industry is highly organised, and the ways and means whereby assistance is rendered by the Government are correspondingly varied. As a general rule, this assistance is largely given through the Department of Mines and Resources and especially through the Mines and Geology Branch. Assistance is further given through the various Provincial Departments of Mines and Geology where these exist.

For example, in 1938, 40 geological parties of the Department of Mines and Resources were in the field engaged chiefly in examining areas that appeared promising for prospecting and in obtaining information to aid in the development of mineral deposits. The Topographical Section had parties working in the Yukon, North-west Territories, British Columbia, Alberta, Saskatchewan, Quebec and Nova Scotia. Moreover, the large number of visits to the National Air Photographic Library by engineers, prospectors, geologists, timber operators, etc., is noteworthy, for it indicates the important part played by aerial photography in the development of Canada's natural resources.

The Bureau of Mines, through its various divisions, correlates and makes available for industry and the public, information pertaining to the production, marketing, and use of the mineral resources of the Dominion. Visits are made to many of the mining areas to collect up-to-date information. In addition it carries on investigations to determine the best method of treating ores and products, both metallic and non-metallic. Such investigations are carried out in excellently equipped ore-dressing, metallurgical, fuel-testing and ceramic laboratories where facilities are available for comparatively large-scale continuous tests and mill runs. This service is a feature of the Bureau and is of considerable practical value to the mining industry generally.

The Department of Mines and Resources also assists in improving transportation facilities into mining areas. In 1938 it administered for this purpose a special vote by Parliament of $1,310,000, as against $1,400,000 for the previous year. Mining road work was carried out largely in those parts of the provinces that are not fully served by regular highways, and this work has continued to reduce transportation costs in many areas where high traffic rates were retarding the development of new properties. During the calendar year 1938, 22 mining companies commenced gold production in areas that have been assisted by mining road construction.

Among the more important construction work carried out during the fiscal year ended March 1939 may be mentioned the completion of the Bowsman-The Pas highway in Manitoba, work on the Rose Lake winter road in Quebec and the Berens River-Favourable Lake winter road in Manitoba and Ontario, and the opening of a winter tractor road in Alberta and the North-west Territories from the Peace River district to Great Slave Lake. In addition to this work an all-weather road was constructed from Goldpines to the Confederation Lake area in Ontario, and considerable progress was made on the road from Fort St. James to the Manson Creek placer area in British Columbia, and on the York River road leading to an area in which mineral prospecting and development is taking place in Gaspe Peninsula, Quebec.

The maximum number of workers employed on all projects in the peak month was 4,300, and the total man-days of work amounted to 272,000. Additional employment was provided in organisations concerned with the supply of construction materials and with the provisioning and equipping of camps. Direct employment alone resulted in the disbursement of $940,000 in salaries and wages, the work having been given chiefly to persons classified as relief and needy cases.

Maximum expenditure provided for under the agreements with the provinces and by appropriations for work in the North-west and Yukon Territories during the fiscal year ended March 1939 was as follows :

Mining Roads.	Maximum Dominion Contribution. $	Maximum Provincial Contribution. $	Total Expenditure Provided for. $
Nova Scotia	25,000	12,500	37,500
Quebec	250,000	125,000	375,000
Ontario	250,000	125,000	375,000
Manitoba	230,000	115,000	345,000
Saskatchewan	125,000	62,500	187,500
Alberta	35,000	17,500	52,500
British Columbia	240,000	120,000	360,000
North-west Territories*	53,250	—	53,250
Yukon Territory	50,000	—	50,000
	1,258,250	577,500	1,835,750

Includes $14,000 *for improvement of navigation on Athabaska River in Alberta.*

The mining industry may further be assisted by Government bounties on coal and iron. In the past bounties have been paid on lead (1897-1916), copper (1923-31), iron and steel (1896-1912), and petroleum (1905-27). In all, $24,235,000 was paid in bounties between 1896 and March 31, 1937.

The present bounty on bituminous coal was the outcome of a recommendation of the Royal Commission on Maritime Claims relating to the use of Canadian coal in the manufacture of iron and steel. The rate is 49½ cents per short ton of bituminous coal mined in Canada and converted into coke and used in the manufacture of iron and steel. The first payment was made during the fiscal year 1930-31, and total payments to March 31, 1937, were $1,000,801 on 2,023,840 tons of coal.

In *Ontario* there is a bounty of 2 cents per unit of iron paid to producers of iron ores delivered to blast furnaces. The legislation was passed by the Ontario Legislature in 1937 and became effective on January 1, 1939, for a period of 10 years.

In *Quebec* the Government proposes to pay a bounty of 2 cents a unit for iron oxide produced as a by-product from the making of sulphur from iron pyrite. The proposal is that the bounty should run for 5 years starting on January 1, 1940. The only stipulation is that iron oxide on which bounty is paid is to be used in manufacture in the province. Authority is also given to pay 2 cents per unit of metallic iron contained in iron ore mined in the province, provided it is treated in the province.

In *British Columbia* a bounty is offered not exceeding $3 per short ton on the proportion of pig iron produced from ore mined in the province, in addition to a corresponding bounty not exceeding $1·50 for material mined outside the province. For steel-shapes of commercial utility manufactured in the province there is a bounty not to exceed $1 per short ton.

The Department of Mines of British Columbia has recently announced a scheme for assisting in the operation of gold properties which are at present idle or on which owners require assistance in

operation. The acquisition of such properties will be strictly on a leasing basis and a mine can revert to the owner at short notice at any time at which the owner so desires.

With regard to the province of *Alberta* the Petroleum and Natural Gas Regulations provide that " where in the opinion of the Minister any well has made a discovery of oil that proves a previously unproven area to be an oil field, he may declare such well a discovery well and in his discretion rebate the royalty payable to the Crown from the products of such well in such manner and to such extent as he may deem expedient."

At the time of writing there is before the Alberta Legislature a Bill, the purpose of which is to authorise the Minister of Lands and Mines to join with other owners of undeveloped mineral resources in the Province with the view to the development of such resources on a unit plan, all owners participating to share both in the expense of such operation as well as in the revenue derived therefrom. The Act, if passed into law, is to be known as " The Unit Operation of Mineral Resources Act."

EIRE

Under the Mineral Development Act, 1940, the Minister for Industry and Commerce may grant licences to approved persons to prospect for minerals on or under any land, whenever it appears to him that these exist and are not being worked efficiently.

The Act also provides for the granting of leases to work minerals in areas in which the minerals are State owned. It provides further for the acquisition of the right to work minerals in private ownership in cases where the minerals are not being worked and it is not practicable for the applicant to obtain by private arrangement a right to work the minerals.

Finally, the Act provides for the granting of ancillary rights to facilitate the working of the minerals when the right to work them has been acquired. These ancillary rights include: a right to let down the surface; a right of air-way, shaft-way, or surface or underground way-leave; a right to dispose in a particular manner of waste products obtained in connection with the working of minerals.

Grants are made out of the monies provided for the relief of unemployment to assist mineral exploration and development schemes. The grants are usually for such purposes as the construction of roads into mines or quarries, removal of overburden, or the provision of natural drainage by means of adits. All grants are subject to conditions determined and agreed beforehand between the Ministry for Industry and Commerce and the grantee. The conditions normally require the grantee to bear an expenditure on the proposed work at least equal to the amount contributed by the State. It is sometimes made a condition of the grant that the

entire amount advanced shall be repaid by means of a royalty on any minerals that may be raised.

Under the Trade Loans (Guarantee) Acts loans, or guarantees in respect of loans, may be given in approved cases to assist mining enterprise to secure loans which might not otherwise be obtainable.

Considerable use is made of the Geological Survey by prospectors and others in consulting maps and obtaining information from officers of the staff. The Survey undertakes the examination and identification of mineral specimens free of charge, but it does not undertake complete quantitative chemical analyses.

Information is frequently sought by the public as to the source of various minerals and raw materials, and such information on the subject as is recorded in published records is made available to applicants.

India

Although direct Government assistance of the type provided by certain Dominions of the Empire is usually not available to the mining industries of India, much indirect assistance is nevertheless forthcoming through the Indian Geological Survey and Department of Mines as well as through the Department of Commercial Intelligence and Statistics. In the past borings for coal, etc., were directly undertaken by the Geological Survey; with the growing interest in domestic industrial development it may be confidently predicted that a greater measure of direct assistance will be available in the future.

The activities of the Geological Survey are directed mainly to the completion of a geological map of India, and to the collection and dissemination of information regarding the mineral resources of the country. The Director gives expert advice with regard to the administration of the rules for the grant of prospecting licenses and mining leases and is consulted on all questions regarding the mineral policy of India. All geological and mineral specimens are examined and identified free of charge, but, except in cases where special circumstances are involved, complete assays and quantitative analyses are not undertaken. These are left to the Government Test House, or to one of the numerous professional analysts in India. Any inquirer can ask with certainty of reply for information on the occurrence of mineral deposits or on statistical data regarding domestic mineral production. The Department issues various publications such as *Records*, containing an annual review of mineral production and papers dealing with economic and scientific matters; *Memoirs*, which are chiefly descriptive and relate to the geology and mineral resources of specific areas; and miscellaneous works such as *Manuals*, *Bibliographies*, *Guides*, etc. It also has an excellent geological museum and a library containing over 60,000 volumes which may be consulted by the general public.

The Department of Mines is very largely concerned with the

administration of the Mining Laws and with the safety and effective management of all mines. The cadre, however, of the Department is comparatively small, and the amount of direct assistance given to the prospector and miner is necessarily small. Statements, however, are prepared annually showing figures of output, labour, etc., from all mines and an annual report is published. Lists of coal mines and other mines being worked are also prepared and kept up to date by the Department. The Department is closely associated with mining education in the country.

The Department of Commercial Intelligence and Statistics forms a convenient link between the commercial public and the Government of India and is responsible for the collection and dissemination of commercial information with a view to the promotion of Indian trade, especially on the export side. It answers trade inquiries, effects trade introductions, disseminates information regarding trade openings in other countries to firms in India, and circulates information regarding Indian produce and manufactures to merchants abroad who are likely to be interested. It is also responsible for the compilation and publication of all the statistical volumes issued by the Government of India. The Department further arranges for the collection of representative samples of Indian produce and manufactures for display at various fairs and exhibitions and also for trial or sample consignments when required.

Jammu and Kashmir.—The Government of Jammu and Kashmir has carried out an extensive mineral survey and has published the results obtained. The Kashmir Mining Department is prepared to assist prospectors by issuing drills on loan, by identifying samples and by giving advice about mineral occurrences throughout the State.

Mysore.—The Government of Mysore maintains a Geological Department, the members of which provide technical advice if required during their inspection of blocks under Prospecting License and Mining Lease. Assays and analyses of minerals, rocks, etc. are carried out for the public on payment of certain fees, while technical investigations are also undertaken if time permits, the actual expenditure incurred being recovered. The Government have allowed preferential rates for mining over certain areas in the case of minerals needing such discrimination, and where industrial concerns mine and utilise large quantities of minerals the royalty has been waived in the initial stages either for a certain period or for a definite quantity mined and used, after which reduced royalties have been allowed. Unoccupied waste land at the disposal of Government has been given free to mineral industries concerns for the erection of their factories, and in cases where lands required for such purposes are in private hands they are acquired and handed over to the concerns, the cost of acquisition being borne by the company. In addition concessions have been made in the rates for water and electric energy supplied to industrial concerns.

The Geological Department periodically publishes the results of its technical investigations and these are available for sale.

NEWFOUNDLAND

The Government of Newfoundland early recognised the importance of a geological survey as an aid to the opening up of the country. The first geological work to be carried out under Government auspices in the island was performed by J. B. Jukes during the years 1839-40 ; it was of the nature of a hasty preliminary reconnaissance, chiefly around the coast, and served to call attention to the coal resources of the west coast.

The first serious attempt at a systematic and detailed geological survey of the country, however, was instituted in 1864 when Alexander Murray began his geological examination of the island, at first under the direction of Sir W. E. Logan, his chief on the Geological Survey of Canada. Murray and his assistant, J. P. Howley, surveyed much of the country until 1883, from which date Howley continued the work alone until 1909. The records of this early survey are to be found in the Annual Reports of the Geological Survey of Newfoundland, issued between 1864 and 1909, and a generalised geological map of the island was also produced. Geological work in the island lapsed until 1926 when H. A. Baker was appointed Government Geologist, an appointment which lasted until 1930. In addition to examining numerous mineral prospects in the island, Baker made detailed studies of the St. George's coal field and the pre-Cambrian rocks of the Avalon peninsula. Much of the interior of the island, however, is still unexamined geologically.

The economic objects attained by the Geological Survey of Newfoundland in the course of its pioneer reconnaissances of the country were largely incidental to the exploration and determination of the general geological background. These have included: an important share in the discovery of the coal basins of Bay St. George and Grand Lake and the determination of the general structure, extent and thickness of the coal beds ; fostering the development of the Notre Dame Bay copper region ; collaboration with the early workers of the Wabana iron ore district and prediction of the great reserves of that field ; determination of the favourable character of the geological structure underlying the St. John's dry dock ; collection of mineral statistics of the island ; institution of the Museum at St. John's ; topographical mapping of the large rivers and lakes and location of the railway route connecting the Hall's Bay road with Port aux Basques ; assistance and advice to prospectors and miners in developing various mineral properties.

The present Survey, directed by A. K. Snelgrove, was inaugurated in 1934 by the Commission of Government shortly after that body assumed control of Newfoundland affairs. It is entrusted with the collection and dissemination of information on the mineral resources and geology of the country, the administration of the mining law,

and the collection of mineral statistics. Following the recent practice of the Geological Survey of Canada and of Surveys in Crown Colonies, field work is devoted primarily to investigations in economic geology designed to foster the mining industry.

In collaboration with the Surveys Division of the Department of Natural Resources, the Geological Survey prepares topographical base maps of areas which appear favourable for prospecting, and issues quadrangle geological maps on a scale of 1 in. to 1 mile. Each quadrangle map contains a simple description of the character and manner of occurrence of economic mineral deposits known to be or likely to be present in the area. Control for topographical maps is being provided by a Geodetic Survey.

A government-owned prospecting diamond drill is loaned to claim holders at cost of operation and an assay laboratory is maintained at St. John's where samples are analysed at moderate cost.

New Zealand

State aid to mining in the Dominion of New Zealand is given in several forms, notably by the activities of the Geological Survey, by direct financial aid to prospecting, by the loan of Government prospecting drills, by subsidies to mining schools, and by subsidies and grants for the provision of roads to mining fields.

The Government has employed skilled geologists since the earliest discovery of minerals in New Zealand. The Geological Survey now carries out systematic mapping, geophysical prospecting and aerial survey of selected areas. Bulletins dealing with mineralised areas are regularly published as well as shorter papers.

The Dominion Laboratory maintained by the New Zealand Department of Scientific and Industrial Research carries out the testing and analysis of mineral samples and mine gases submitted by working mines and prospectors.

As an aid to the development of the mining industry, the Government offers varied and liberal assistance to prospectors in the form of subsidies, expert technical advice, use of plant, etc. Subject to the provisions of the Mining Act, the holder of a valid miner's right is entitled to prospect for any mineral except coal on any Crown land. He may also obtain authority from the Governor-General to prospect on native land, and he may prospect on private land with the consent of the owner. Prospecting licenses for coal are issued with the consent of the Minister of Mines.

During the year ending March 31, 1939, a total of £3,703 was expended by the Mines Department in subsidies for prospecting (exclusive of £4,249 in connection with the prospecting schemes of the Employment Division of the Labour Department) and 53 persons were given employment thereby. Up to the March 31, 1939, the Labour Department continued its assistance to the gold-mining industry and expenditure in this direction from the Employment Promotion Fund for the financial year amounted to £50,271.

In addition £13,752 was advanced to gold-mining companies by way of loans.

Gold won by subsidised prospectors during the year was approximately 3,350 oz.

Prospecting drills of various types suitable for the conditions existing in the Dominion are lent to *bona fide* prospectors. A monthly rental is charged for the plant, and the hirer is required to maintain it in good order and make good any damage, including the loss of diamonds. In 1938 an aggregate of 14,072 ft. were drilled in 341 holes for eleven parties utilising Government drills.

The Government subsidises seven Schools of Mines and one University School of Mines, while the Mines Department annually offers six scholarships each tenable for four years. In the financial year ending March 31, 1939, Government expenditure on these schools was £3,460. The expenditure in the form of subsidies and direct grants upon roads on goldfields during the same period amounted to £5,221 as compared with £16,869 during the previous year.

Another form of Government assistance to mining enterprise is the publication of leaflets as a guide to prospectors. These leaflets, which are obtained on application to the Mines Department, deal with (*a*) the description of fields which may be considered to warrant further examination for gold; (*b*) the description of the best ways of seeking for and of saving gold; (*c*) a brief summary of the statutory procedure to be followed to obtain a right to prospect for, or mine, metals; (*d*) notes on the taking of samples and the valuation of mining prospects; (*e*) notes for drilling and a method of calculating values of alluvial gold deposits.

The State also assists the iron and steel, and coal industries. The Iron and Steel Industry Act of 1937 made provision for the reversion to the Crown of privately held licenses and leases over the Onekaka iron-ore bodies, and gave authority for the establishment of a State-operated iron and steel works which will assist the consumption of coal by its use in steel production. The Minister of Mines also has authority (Coal-mines Amendment Act of October 1935) to purchase, store and treat coal slack, with the object of finding markets for this formerly unmarketable product.

Southern Rhodesia

The mining industry of Southern Rhodesia, which is largely operated by small workers, receives both direct and indirect assistance largely through the Mines Department, which is organised in three sections—administrative, technical (including metallurgical), and geological.

Assistance to about 700 small workers has been provided through the Loan Funds Account which was instituted in 1924. The objects of the original scheme were firstly to give assistance to prospectors to find new ground, and secondly and mainly to assist those holding

claims with reasonable prospects to develop and extract minerals. In addition the fund was used for financing research, assays, metallurgical tests and the provision of other technical services.

The Loan Funds Account is administered by the Loan Funds Committee, and up to March 31, 1940, the total sum advanced was £491,905 0s. 9*d*. The usual applications for loans range from £250 to £2,500, though sums as small as £5 and as large as £10,000 have been advanced. The loans are repayable in easy instalments and interest at the rate of 6 per cent. is charged. Of the total advanced 60 per cent. has been repaid, 31 per cent. is outstanding and 9 per cent. has been written off. If it is assumed that 25 per cent. of the outstandings will prove to be bad debts, the losses can be put at about 17 per cent., which, taking everything into consideration, is not too high for an undertaking of this nature, and the value of creating producing mines to the Colony generally cannot be overestimated.

The prospecting part of the scheme did not prove a success; no properties of any value were discovered and it was abandoned in 1926. The principal defect was that the scheme did not attract the really skilled and experienced prospector as he could usually make his own arrangements without assistance from the Government. It was not until 1932 that any form of assistance to prospectors was revived and it was then re-introduced to find employment for a number of unemployed during the depression period. Two or three ore bodies were located, but nothing of real value was discovered, and for the second time the scheme was dropped. It was revived again in 1936 and at the present time grants are available to prospectors who, in the opinion of the Government Mining Engineers, have sufficient experience to carry out the work.

The main branch of the scheme, namely, the advance of loans for the purpose of development and the provision of machinery, has been more successful, and there are undoubtedly many properties whose existence can be placed to the credit of the fund.

The scheme has not been used to assist the gold industry alone, for in 1925 and 1926 attempts were made to establish the platinum industry in the Belingwe district. At the same time attention was given to the mica industry and a quantity of mica was exported to London until the depression in 1931. In 1936 the industry was revived and small but regular shipments of mica are going forward. Help on similar lines has been extended to owners of chrome, tin, corundum and nickel claims in an endeavour to stimulate the production of these commodities.

The Government, through the Loan Funds Committee, purchased seven portable compressor plants and jackhammers, which were available at a fixed rate of hire, for speeding up development on mines where such a course was recommended. The provision of these plants served its purpose by demonstrating the advantages of pneumatic drilling. Many miners installed their own plants and the

demand for the use of Government-owned plants fell off to such an extent that they were sold and this form of assistance dropped.

The Government, under the Irrigation Department, has a drill for use in boring for water, which is allocated specially to small-workers. The provision of this drill enables some of the dry mines which are closed down periodically on account of water shortage to obtain water with which to continue their crushing operations throughout the year.

During the period 1934-38 the Government embarked on an extensive drilling programme on approved properties. This work was undertaken by contractors, and the cost of boring, unlike the loans previously mentioned, was met from Revenue funds and considered to be a debt on the property, not a personal liability. The owner of a property therefore, on which the Government drilling took place could free himself of all liability by forfeiture or abandonment of his claims. The boring operations achieved a reasonable measure of success and have been the means of reopening a few derelict mines.

A well-equipped metallurgical laboratory has been established in Salisbury at which free tests of ore are carried out by qualified professional officials. A limited number of learners in metallurgical work are admitted to this laboratory. Assays are carried out free for prospectors who are considered not to be in a position to pay the usual assay fee charged by private assayers. An assay office has also been established in Bulawayo.

A Mine Training School has been established at Bulawayo as part of the Bulawayo Technical School with gratifying results. At this school youths may be trained in all branches of mining and given practical experience at various mines in the Colony. By this means it is hoped to provide trained miners and thus fulfil a need which has always been apparent. Tuition at these courses is free and boarding grants are available in approved cases.

A Government roasting plant has been erected at Que Que for the treatment of concentrates from sulphide ores. The main concentrates received are those containing mispickel. Concentrates containing some antimony, a little lead, or other base metals are also treated, but none of these metals are recovered in the process.

An Electricity Supply Commission was established by the Government primarily to enable mines to obtain cheap power. This undertaking has been in operation for several years and its network of power lines covers a very large percentage of the gold mining area in the Colony. The charges made are very reasonable and have resulted in many mines changing from steam or oil-driven machinery to electricity.

Pamphlets on various subjects prepared by the administrative and technical staff are available gratis on application to Mining Commissioners' offices.

The Mining Engineers' staff of the Government consists of 14

fully-qualified engineers under the Chief Government Mining Engineer and they are available to assist the small worker in all his problems. In addition to mining engineers there are two mechanical and electrical engineers and six surveyors.

The Geological Survey Department which was established in 1910 systematically maps out the geology of the country, particularly of the gold belts, and examines individual mines. It publishes the results of its work in the form of bulletins, short reports and maps; single copies of papers dealing with areas in which prospectors or miners are interested are issued free of charge. The staff consists of the director, five geologists, a chemist, a mineralogist, four draughtsmen, a librarian and a clerk.

Union of South Africa

The Geological Survey of the Union came into being in 1910, incorporating the Geological Commission of the Cape of Good Hope, started in 1896, and the Geological Survey of the Transvaal which had been re-commenced in 1903. A short-lived geological survey had been initiated in the Orange Free State in 1878, while Natal and Zululand had a geological survey from 1902 to 1906. These surveys have produced a large number of reports, memoirs, geological maps with explanations, and special publications of various kinds covering the geology, both academic and economic, of a large part of the country.

There has been a great increase in the staff of the Geological Survey, which is a branch of the Department of Mines, during the last few years. Special attention is being paid to the economic aspects of the work and a complete survey of the base mineral resources of the country is now being undertaken, together with work on the selection of bore-hole sites for underground water. Air photographs and various types of geophysical instruments are being increasingly used. The identification of minerals for prospectors is undertaken free of charge by the Geological Survey, and the analysis of prospectors' samples is performed at the Government laboratories at Johannesburg and Cape Town under a very reasonable tariff of charges. Samples either for identification or analysis are conveyed by post or rail free of charge.

The Government has afforded considerable aid to mining in the Union, and this has been done in many ways, but that more might be done in this respect is evident from the recently issued report of the Committee of Enquiry into the Base Mineral Industry of the Union which is referred to later.

It is provided under the Transvaal Precious and Base Metals Act of 1908 that the Minister for Mines may, out of moneys appropriated by Parliament for the purpose, assist the prospecting for and exploitation of precious or base metals: by erecting batteries, smelting works, ore dressing works, assaying and analytical laboratories, power stations, and pumping stations; by the construction

of roads, pipe lines, power lines, and water courses ; by the sinking of boreholes, and generally in any other manner prescribed by regulation he may deem expedient. He may charge fees for the use of anything so erected, constructed, or sunk, and do all acts and things and enter into all contracts necessary for the purposes of this section.

The Minister may, so far as he deems expedient, permit any officer of the Mines Department to advise any prospector or holder of mining title on any matter which relates to prospecting or mining for precious or base metals.

In several cases assistance has been granted by the Government to large mines giving employment to a number of European and native workers in order to tide such mines over difficult times and to prevent closing down. Provision was made for repayment out of future profits of the amounts of such assistance, and it is satisfactory to note that in all such cases the assistance given has proved to be of immense advantage, not only to the mine and to the community surrounding it, but also to the State by reason of the continued working of the mines, which resulted in revenue direct and indirect, less unemployment, and the ultimate repayment of the amount of the loan.

For many years indirect assistance has also been given to small mines in outside districts by means of the provision of mines roads, and the construction and repair of drifts and bridges, a policy which has undoubtedly been of great assistance to district mining development. The expenditure on roads, drifts, and bridges for small mines during 1939 in the Union was £41,032.

In order further to encourage prospecting and the development of mineral resources in outside districts, Parliament during the financial year 1936-37 voted a sum of £40,000 for the purpose of extending assistance to small mines, and a scheme was evolved providing for direct financial assistance by way of loans for development.

As a result of experience gained it was decided to extend the scope of the scheme not only to provide for more liberal financial aid for development but also to include financial assistance to cover the cost of plant and machinery for development and production, and to this end the provision made by Parliament for assistance to small mines was much increased.

Other assistance in the form of advice and guidance, which more often than not called for sampling and surveying, was also extended, whilst more recently a metallurgist has been added to the Small Mines Assistance staff to advise on ore treatment and plant construction.

As an indication of the manner in which the scheme is operating it might be mentioned that since the inception of the scheme 372 applications have been dealt with, whilst during the last normal year (ended December 31, 1939), at no cost to applicants, 3,135 samples were taken and assayed, 42 plans prepared and 24 metallurgical investigations carried out.

The advent of war, of course, has seriously interfered with the progress of the scheme because of the necessity for conserving Government funds and although every inducement is still being offered for the promotion of the development of strategic base minerals, no new assistance for the time being is available for gold propositions.

The Mines Department has also provided a number of boreholes with pumps in the Leydsdorp division of the Pietersburg district, Transvaal, for the purpose of supplying water to prospectors and others in that area, and the maintenance of some of these boreholes and pumps is still a charge against the vote of the Mines Department. Others, which fall on land which has been disposed of to settlers, are maintained by the settler in return for the right to take such water therefrom as he may require.

In cases where prospecting claims are being worked remission of the Government's share of licence money is granted provided that a certain amount of work has been done on the claims, and, in the case where the claim-holder is a company, that no dividend has been paid to shareholders in respect of the last financial year.

The institution of a Minerals Research Laboratory in 1934, where ore treatment investigations are carried out, will, it is expected, prove of increasing importance to the industry. Up to the present, investigations have been carried out in connection with the treatment of corundum, phosphate rock, andalusite, magnesite, chromite, gypsum, and Black Reef gold ore, and considerable progress has been made. The policy adopted by the controlling committee has been to undertake the investigation of all mineral problems which normally do not fall within the scope of private metallurgists, and which are considered by the committee to be of national importance.

The Government Mechanical Laboratory is well equipped for testing all structural materials in addition to the testing of winding ropes, which forms the greater part of its work; numerous tests are carried out on steel, concrete, bricks and other building material. During the past year an increasing number of contractors and architects have made use of the facilities of the laboratory for testing concrete, reinforcing-steel and other materials.

The Sabie Gorge hydro-electric undertaking was established by the Electricity Supply Commission for the purpose of supplying electric power to the mines in the Sabie area of the Pilgrims Rest Mining District.

The Fuel Research Institute, which was established in 1930, has done a great amount of useful work and is undertaking, in conjunction with the Geological Survey, a survey of the fuel resources of the Union. This body is also entrusted with the administration of the Coal Grading Act.

The Government has also rendered assistance in the direction of the establishment of permanent industries by engaging the services

of experts from overseas to investigate and report upon the possibilities of increasing the production of iron and of producing petroleum in the Union. The Department of Mines has further helped to direct public attention to specific mineral possibilities by the publication of memoirs or contributions in official or other publications.

The Mineral Development section of the Mines Department, whose task is to promote the development of mineral deposits, to explore markets, to keep local producers informed of current prices, and to bring local producers into contact with exporters and overseas consumers, is stationed at Johannesburg.

An Overseas Representative, who is a technical officer of the Mines Department, has for several years been attached to the office of the High Commissioner in London for the purpose of investigating the technical requirements of overseas markets and generally of promoting contact between consumers overseas and producers in the Union.

The whole question of Government aid to the mining industry has recently been the subject of a report issued by a Committee of Enquiry into the Base Mineral Industry of the Union set up under the chairmanship of Dr. R. B. Young by the Minister of Mines in December 1939. This committee had to consider, firstly, the best means of encouraging the economic development of the base-mineral resources of the Union to the fullest possible extent ; secondly, the better utilisation of base minerals, by increasing local consumption, by local treatment of ore for export, and by other means ; thirdly, the coal industry of the Union with special reference to the internal market, the present conditions under which coal is exported, the desirability of increasing or decreasing the volume of export trade, the effect on national interests of the export trade in coal, and the methods of mining and production of coal.

This Committee suggested that a Mineral Development Section of the Mines Department be set up, the functions of which would be, generally, the promotion, control, and co-ordination of efforts to stimulate and assist the development of the mineral industry of the Union, in so far as these lie within the sphere of the Department of Mines, and the co-ordination of such efforts with those being made by the Department of Commerce and Industries. It would take over the control of the Base Mineral Development and Small Mines Assistance Office and also that of the Minerals Research Laboratory to the extent at present exercised by the Mines Department. Should other recommendations regarding the Fuel Research Institute be acted upon, that body also would come within the purview of the section. The near relationship of the activities of the organisations mentioned to the work which falls within the sphere of the Geological Survey of the Union (which for a number of years has given increasing attention to the more economic aspects of Survey work) necessitates the closest co-operation between these bodies. In order to facilitate this desideratum and to afford greater opportunity for co-ordination

the Committee recommends that the Geological Survey, which at present occupies a somewhat isolated position in the Mines Department, be brought within the engineering branch of the Department.

The report also reviews the various organisations brought into being in order to further the interests of the base mineral industry, viz., the Inter-departmental Base Mineral Development Committee, appointed in 1933; the Base Mineral Development and Small Mines Assistance Office, created towards the end of 1933; the Minerals Research Laboratory, established in 1934; the Fuel Research Institute of South Africa, established in 1930; and the Geological Survey of the Union. The Committee make recommendations with regard to changes in, or amplifications of, the functions of these bodies.

They agree with the general opinion that, owing to insufficient co-ordination of their activities, the State is not reaping full advantage from these establishments. It is evident (states the report) that during the last few years some change in the orientation of the functions of the Department of Mines of the Union has been taking place. The present organisation of the Department is based on that of the Mines Department of the Transvaal Republic and still bears the impress of wear belonging to earlier days. The statutory functions of the Department consist mostly in the administration of the mining laws and the enforcement of regulations framed thereunder.

It is further suggested that the opportunity be seized to amend the mining law in such a manner as to remove, or at least lessen materially, the restraints on prospecting and mineral exploitation. The Committee point out the minor defects in the law that deserve attention—namely, the excessive rents charged on discoverers' and other mining leases in respect of base minerals; the difficulties placed in the way of prospecting in native areas and locations, and the opportunities afforded under the Cape mining laws of holding prospecting areas for purely speculative purposes. The report goes on to recommend that where prospecting, though manifestly in the national interest, does not present sufficient inducement to private parties it should be undertaken by the State. On the subject of State financial assistance to the base mineral industry the Committee hold that any general rules that can be laid down must necessarily be of an axiomatic character and of very much wider application. Thus the advisability of rendering such assistance and its appropriate form should in every case be subject to the most careful investigation. Indirect financial assistance, if applicable, is stated to be preferable to direct assistance and the latter should always take the form of an advance and should be given only when a reasonable hope exists of its eventual return. State assistance is most welcome and effective in the early stages of mineral exploitation and the Committee recommends that the provisions of the Namaqualand Copper Mines Income Tax Act, allowing for the

redemption of capital expenditure before income tax is imposed, be applied more widely to base mineral enterprises in the Union.

Early in 1940 the Governor-General appointed a Commission to undertake a comprehensive survey of the Union's industrial and agricultural requirements with the object of determining to what extent those requirements can be met from the Union's own resources and the steps that require to be taken to increase the output and utilisation of local raw materials and to increase the Union's productive capacity.

This Commission has not yet completed its task, which includes a re-survey of the mineral and mining potentialities of the Union and of the extent to which mineral production and utilisation can be increased. Two interim reports have been published.

The Government contributes towards the expenses of Government Miners' Training Schools, which were started in 1911 to train a certain number of South African youths to fill the demand for experienced miners which was becoming acute on account both of the rapid expansion of the industry and of the reduction in the number of men from overseas coming to South Africa. The work of these schools has grown until there are now six schools situated on mines on the West, Central, and East Rand. In these schools nearly a thousand apprentices receive a thorough grounding in practical mining, supplemented by a series of lectures, in a course which lasts from 18 months to 2 years. While the schools do not profess to do more than impart the necessary knowledge to enable apprentices to become good practical miners, it is satisfactory to note that a number of the pupils have proved capable of holding official positions to which they have been promoted.

Anglo-Egyptian Sudan

Mining in the Sudan is on a very small scale, and there has been little call for Government assistance which has been limited to the remission of import duty and the introduction of preferential railway rates on mining machinery. Royalty is low, being on a 2 per cent. *ad valorem* basis and recoverable from Business Profits Tax. In the case of companies registered in the United Kingdom, the profits tax is based on British income tax assessments which make substantial allowances for development expenses.

Prospecting licences are normally granted on a yearly basis against payment of a nominal fee with provision for renewal, and individual mining concessions are the subject of negotiation with the Government, who may grant such special facilities or assistance as may be merited in any particular case.

The Sudan Railways operating the largest workshops in the country is able to effect all kinds of repairs.

The Government Geologist extends his assistance to prospectors, but in the absence of a laboratory or equipment for identifying or analysing samples the extent of his assistance is limited, but

proposals for the establishment of a better equipped Department of Geological Survey are unlikely to be considered until after the war.

BECHUANALAND

In the Protectorate of Bechuanaland there is no official Geological Survey. Prospecting and mining in the country with the exception of the Tati district is governed by the Mines and Minerals Proclamation of 1932. By this, prospecting is allowed on Crown land either under prospecting permit or by an exclusive right under Crown grant issued by the High Commissioner. On land within a Native Reserve, and which has been granted under concession made by the Chief and Tribe with the approval of the Secretary of State, prospecting may be carried out if a prospecting permit is obtained by the concessionaires.

It is not proposed to open private land for prospecting or to allow further concessions on Native Reserves.

Both Europeans and natives may obtain prospecting licences. Gold claims are 400 ft. × 150 ft., and licences cost 1*s*. per claim for the first year, 12*s*. for the second to fourth years and 60*s*. thereafter. Up to 500 may be pegged by the finder but no limit is imposed on the holder of a mineral concession. As from September 3, 1939, a premium tax on all gold won in the Protectorate was imposed, but in order to help the small miner no tax is payable on monthly productions of 50 oz. or less. Provision also exists in the law for exemption, either in part or in whole, from the payment of the tax, if it is considered necessary for the efficient development of a mine, for the total monthly output of whatever quantity.

Mining and prospecting in the Tati District is subject to the rules and regulations of the Tati Co., Ltd. (*vide* Mining Rules and Regulations 1916). Prospecting licences may be obtained at a cost of £1 and confer upon the holder an exclusive privilege for specified periods. The Tati Co. does its utmost to encourage prospecting within the district.

Government aid is granted for water boring as financial circumstances permit.

BRITISH GUIANA

Under the direction of the Colonial Office a geological survey of the Colony was carried out between 1867 and 1870 by J. G. Sawkins and C. B. Brown and continued by Brown for some years more.

Between 1897 and 1905 Sir John Harrison (Government Geologist) assisted by H. I. Perkins (Acting Commissioner of Mines) undertook a geological reconnaissance of the goldfields of the Colony. Sir John Harrison then became Director of Science and Agriculture and continued his geological work, producing reports on bauxite and on the occurrence of petroleum and pitch in the Colony. In 1917 E. E. Winter, of the Lands and Mines Department, investigated ironstone and bauxite deposits. In 1925 H. J. C. Conolly was

appointed Government Economic Geologist and Mineralogist and later S. Bracewell became his assistant. Detailed surveys of the Mazaruni and Puruni diamond fields and of the Potaro goldfields were carried out until the staff resigned in 1928.

As a result of a loan of \$39,830 from the Colonial Development Fund for the purpose of carrying out an economic mineralogical and geological survey of the territory through which the new Bartica-Potaro-Tiboku roads pass and the area thereby made accessible, a fresh geological survey was commenced in 1933 with D. R. Grantham (seconded from Tanganyika) as Director. A further loan of \$33,600 enabled the survey to continue during 1934 and 1935, and ultimately a free grant of £22,000 was made from the Fund to enable the work to continue during the years 1936-39. D. R. Grantham returned to Tanganyika in 1936 and was succeeded as Director by S. Bracewell.

The survey is still in existence but its continuance is at present under consideration. Most of its work has been the examination of areas where gold was known or presumed to occur, and it has materially assisted in raising the gold output of the country to its present high level. The survey has provided reliable information on the potentialities of the gold producing areas, and largely in consequence of this, considerable interest has been evinced by mining companies in the possibilities of large-scale development. Since 1933 the area held in the form of exclusive permissions has increased from 279,189 acres to 1,257,438 acres, and in the form of mining leases, grants, and mining and dredging concessions from 3,021 to 24,127 acres. During the same period the value of mineral exports has increased from £301,905 to £717,954 or from 13 per cent. to 26 per cent. of the total value of the Colony's exports. It is estimated that during 1938, apart from expenditure upon machinery, etc., a sum of at least £40,000 was spent in the Colony by mining companies in the investigation of mineral resources.

One of the most important aids to the mining industry in the Colony has been the construction by Government of the Bartica-Potaro road and its extensions which have opened up much new gold-bearing country.

Much has been done to stimulate prospecting and sums of money have been advanced to assist in financing prospecting parties, e.g. in 1932 five prospecting crews of 22 men under experienced prospectors were organised and sent to various areas. Again, in order to relieve unemployment among miners, a scheme to provide 40 men with free transport, food for the journey, minimum equipment of tools, proved ground on which to work, control of operations, and recovery by instalments from their earnings proportionate to results, was put into force in 1933 and proved successful. Government also assisted claimholders by advances or guarantees to acquire pumps necessary to handle more ground, and recently made a trial of a scheme for "grub-staking" unemployed miners.

Ceylon

On the recommendation of Professor Wyndham R. Dunstan, then Director of the Imperial Institute, a Mineral Survey was established early in 1903 with the object of examining the occurrence and possibilities of development of the economic minerals of Ceylon.

The Mineral Survey, reinstituted after a break of five years in 1938, is now known as the Department of Mineralogy, and has as its principal aim the preparation of a geological map of the country on the scale of 1 in. to the mile. It maintains a laboratory and a geological museum, and undertakes the examination and analyses of mineral and rock samples. Advice is provided to the public and to Government Departments on the commercial possibilities of economic minerals (including ores, gems, etc.). The Department also undertakes the investigation of water supply problems and conducts boring operations. Close liaison is maintained with the Imperial Institute, and recent enquiries undertaken by the latter body include an investigation into the possibilities of utilising coral in the manufacture of cement, the potentialities of the huge quartz-sand beach accumulations for the manufacture of glass, advice on the marketing of ilmenite sand, etc.

In 1939 a sub-committee, appointed by the Government to report on the marketing and cutting of gems in Ceylon, recommended that a Government Institute to instruct natives in gem-cutting be set up as part of the Department of Mineralogy.

Gold Coast

The mining industry of the Gold Coast, though founded primarily on the recovery of gold (an art dating back to remote antiquity), owes its present virile position in no small measure to the excellent pioneer and reconnaissance work of the Geological Survey, officially formed in October 1913. This Survey has been responsible, *inter alia*, for the discovery of important and valuable deposits of manganese ore, diamonds and bauxite, and, moreover, has played no small part in the opening-up of these deposits by encouraging influential companies to work them. Whilst no direct financial aid is given either to large or small-scale mining concerns (for the nature of the deposits and the country is not such as would generally warrant this), the Survey renders much practical assistance by describing new mineral deposits, by collecting and disseminating information as to the occurrence and extension of known deposits, and by freely placing at the disposal of the industry the expert and technical advice of the Director and his staff.

Assistance is further rendered by the Mines Department, which has been in existence since 1902. This Department not only undertakes duties connected with the general safety of the workers, but publishes reports summarising the work carried out by various mining companies and giving detailed statistics of domestic production.

The Government has made provision for the remission of the gold premium when a loss is incurred in mining and has also undertaken the construction of roads to certain of the mines.

In the early stages of its development the work of the Geological Survey was chiefly confined to covering the country as rapidly as possible by a network of reconnaissance traverses. The efforts of the geologists were soon attended with success, for in 1914 Mr. Kitson (later Sir Albert Kitson) discovered the large deposits of manganese ore at Nsuta, which are now being worked on a large scale, and the bauxite deposit at Ejuanema (4,000,000 tons reserves), near Nkawkaw railway station. In 1919 the first diamonds were discovered at Abomoso by Mr. Kitson and Dr. E. O. Teale (later Sir Edmund Teale), and in the following year Mr. Kitson and Dr. Junner (the present Director of the Survey) found diamonds at many places between Oda, Kade and Manso. The diamantiferous gravels in this area are now being worked extensively by companies. Diamonds are also worked near Dompim in the Tarkwa District, the original discovery being made by Dr. Junner in 1922.

In 1921 and 1922 the large bauxite deposits near Sefwi Bekwai and Yenahin were discovered by the Geological Survey, the latter by Dr. W. G. G. Cooper; this is the largest deposit of bauxite in the Gold Coast and contains an estimated reserve of 168 million tons.

Latterly the work of the Geological Survey has been of a more detailed nature, but reconnaissances are still being carried out in districts not previously examined. Detailed investigations have been made of the Tarkwa, Prestea, Ashanti and Konongo goldfields, as well as of the Birim diamond field, the Nsuta manganese deposits, and the chief bauxite deposits. A comprehensive survey of the gold resources of the Colony and Ashanti has been carried out, and the Northern Territories have been investigated. During the course of this work many new occurrences of gold, diamonds, manganese and other minerals were found.

The first provisional geological map of the Gold Coast was published in 1928 and a revised map was issued in 1940. In 1934 a new geological map of the southern section of the Gold Coast, on which is shown the gold mines and prospects, was published.

Kenya

The official activities relating to mining and geological matters of the Colony and Protectorate of Kenya have for some years past been carried out under the auspices of a single department known as the Mining and Geological Department.

Various areas of the Nyanza Province have been aerially surveyed in accordance with the conditions on the grant of certain exclusive prospecting licences, but the use of this method of survey for other portions of the Colony by Government is still under consideration.

The Mining and Geological Department, in addition to administrative duties, carries out the exploration of selected areas, and

publishes notes on the geology and maps of areas thrown open to public prospecting. A special grant of £30,000 was made from the Colonial Development Fund towards the exploration and development of the mineral resources of certain areas of the country. On the outbreak of war this grant was reduced to £15,000 and the programme was modified accordingly. Work in connection with this scheme is now proceeding in three selected areas of the Colony of a total area of approximately 4,085 sq. miles.

The Department gives advice to the public on the development, sampling and valuation of mineral deposits, on metallurgical problems, water supply, land utilisation and building materials, while technical advice is provided to the Committee on Mining Law. A special publication entitled *Notes on Methods of Gold Recovery* was issued recently.

A Government laboratory is maintained to undertake the examination, analysis and assaying of mineral samples. Newly discovered material is examined free of charge and first analyses are also free if they are considered to be of sufficient interest. A Geological Museum is also maintained and includes a general rock collection, a regional rock collection and a mineral collection.

A brochure entitled *Mining in Kenya* was issued in 1938 with a view to arousing public interest in the Colony and to attracting prospectors. This had a wide circulation in Great Britain and amongst visitors to the New York World Fair.

Mining machinery is exempted from Customs duty and certain preferential railway rates in respect of various mining requisites have been obtained.

With regard to royalty on gold, in order to help the small producer, mining concerns selling less than 120 refined oz. in any one year can obtain a refund of any royalty paid on such gold.

Malaya

Federated Malay States.—As in most other Empire countries, the Geological Survey and the Mines Departments are the two principal channels in Malaya through which the mining industry derives Government assistance. Both Departments issue annual reports containing pertinent information of general and statistical interest to the mining community ; special reports are also compiled on certain mining properties and on various engineering schemes for the Government, for the Malaya Command, and for the public. Geological reports are furnished to the public on payment of a fee of 50 dollars for each day's field work, expenses being charged in accordance with General Orders of the Federated Malay States.

The principal aim of the Geological Survey is to investigate the mineral resources of the country, the greater part of which still consists of little-explored jungle. Many years must necessarily elapse before a sufficient proportion of the country is adequately explored geologically in order to ensure that prospecting operations

are always conducted in the most favourable localities. But much useful work has already been done, notably the excellent provisional "Geological Map of Malaya," Mr. J. B. Scrivenor's very readable books on *The Geology of Malaya* and *The Geology of Malayan Ore Deposits*, and Mr. E. S. Willbourn's contributions to Malayan geology incorporated in the Chief Inspector of Mines' valuable and comprehensive account of *Mining in Malaya*. Six geologists are now making detailed geological surveys of selected districts in the Federated Malay States. Regional maps of all four of the Federated Malay States have been prepared, dividing their territory into the following four categories: *Mining land*, which includes land alienated for mining, some land near it, and old mining land; *Potential Mining Areas*, which include an extension of mining areas and tracts in the Main Range granite; *Possible Mining Areas*, which include certain areas where a reconnaissance geological survey has indicated the chance of mineral deposits; *Areas not likely to be required for mining*, which include all areas that do not fall within any of the above three zones. Certain parts may be shown by future geological investigation to be "possible" mining areas. It has been possible to prepare such maps only by using the accumulation of facts provided by geological survey work carried out during the past 37 years, including a study of the known mining fields and of the collected results of prospecting. As the area of completed detailed geological surveys increases, so will the regional maps become more accurate and it will become more and more possible to direct the attention of prospectors to localities where there is a good chance of success. Eventually the information given by detailed geological surveys conducted in all mineralised districts, combined with the facts afforded by prospecting, will permit of the production of regional maps of the Federated Malay States clearly divided into land of two categories only, "mining land" and "land of no use for mining." Our present knowledge of Malaya's mineral resources is still far from perfect.

The Geological Survey maintains a free service of information regarding mineral inquiries, as well as on problems dealing with water supplies and road metals. The results of chemical analysis and microscope examination are co-ordinated to solve ore-dressing problems. Ores, minerals and rocks are received for identification, a service for which no charge is made if the specimens are from the Federated Malay States, and if the exact locality is disclosed. Banka-drill bore-samples are also examined for prospectors who wish to make sure that bedrock has really been reached, and that no possibility remains of an occurrence of alluvial tin deposits beneath the lowest depths reached by their bores. Hard granite and metamorphosed sedimentary rocks have suffered decay through weathering to such an extent that boring tools penetrate them with no greater difficulty than is met in alluvium, and the churned up samples brought up are not always easy of identification.

Examples are on record of alluvial overburden having been wrongly identified by prospectors as fine-grained decomposed granite; in actual fact there were payable tin deposits below it.

The Mines Department is a Federal Department with its head, the Chief Inspector of Mines, at Kuala Lumpur; almost the whole of the officers, however, are allocated to the individual States of the Federation, with their emoluments borne by the State budgets.

A certain amount of boring is carried out by the Department, but, unfortunately, both staff and available finance are inadequate for the purpose. A scheme is under consideration to enable both the Mines and Geological Departments to scout bore areas, such as proposed and existing reserves, where it is not desirable that private enterprise should do the prospecting in the first instance. A Government boring programme such as this is deemed desirable in order to prevent payable mineralised areas being alienated for other purposes and so lost to or rendered uneconomic for mining.

Following a complaint from the mining industry that mining and prospecting applications were not meeting with the sympathetic treatment which is necessary if the new alienation policy announced by Government in 1937 was to prove successful, a Regional Planning Committee was appointed in 1938 in Perak under the chairmanship of the Kinta District Officer. Its function is to make a comprehensive survey of the needs and resources of the State in respect of land available for mining, agriculture, forestry and other forms of development with a view to the establishment of an ordered policy of alienation. No meetings, however, of the Committee were held during 1939, and in view of the proposed alienation policy submitted by the Mines Department, which is now under consideration of Government, the Perak Regional Planning Committee will probably be abolished.

The Mines Department in certain instances grants rebates. Thus the Phoenix Tin Ltd. (a lode mine in Upper Perak) was granted an annual rebate amounting to 75 per cent. of the tin duty as from July 1, 1938, subject to such refund being spent on underground prospecting. The concession was renewed in 1939. The total rebate amounts to $11,291, of which $9,978 was in respect of 1939. In 1939 Rawang Concessions Ltd. were also granted a rebate of $1,347 at the rate of $2 per bhara of tin.

At the invitation of the Secretary of State for Colonies, Sir Lewis Fermor, formerly Director of the Geological Survey of India, arrived in Malaya on March 30, 1938, for the purpose of rendering advice in respect of the Mining and Geological Survey policy. A notification in the Malayan press stated that the object of the visit was "to make a full investigation of the present conditions and future prospects of the mining industry and to report to His Excellency the High Commissioner on mining problems generally." Sir Lewis Fermor's investigations and conclusions have since been

made available in a comprehensive *Report upon the Mining Industry of Malaya*, published in Kuala Lumpur in 1939, price $2.50, 240 pp. (with geological map).

Unfederated Malay States.—In view of the fact that mining in the Unfederated Malay States is mainly carried out by people of fairly substantial means, the need for extensive government assistance does not arise. In Trengganu, for example, assistance is confined to the provision of access roads. In Johore preferential railway rates are allowed for full train loads and advice is given to prospectors by the Mines Department free of charge and analyses of samples carried out for a small fee.

Nigeria

A Mineral Survey was established in 1903 under the auspices of the Imperial Institute, and was charged with the work of exploration of the mineral resources of Southern Nigeria with the object of obtaining accurate information respecting the occurrence of minerals of economic importance as a first step towards their development.

A Mineral Survey of Northern Nigeria was sanctioned in 1904 and was established in a similar manner.

The present Geological Survey, besides carrying out the normal duty of geological investigation and mapping, concerns itself with questions of water supply and with the necessary drilling operations. It also keeps in close touch with economic operations of private companies in the search for oil and the exploitation of economic minerals. Investigations of mineral samples sent in by individuals are carried out in the Department's laboratory and a museum containing extensive foreign and local collections is maintained.

The Mines Department primarily concerns itself with the administration of the mining laws, collection of revenue, conditions of labour, etc. In addition the Department is interested in the provision and maintenance of Government roads which open up mining areas. The Department also maintains an Archæological and Mineral Museum.

Northern Rhodesia

The official administration of mining and prospecting in Northern Rhodesia is conducted by the Mines Branch of the Department of Lands, Mines and Surveys. Mineral rights within the entire territory are vested in the British South Africa Company. Outside Barotseland, which is closed to prospecting, the greater part of the Colony has been prospected by large companies holding exclusive prospecting licences which have now expired. The areas are now open to general prospecting and licences can be obtained from the Local Secretary of the British South Africa Company at Lusaka.

Nyasaland

The original mineral survey of Nyasaland was carried out in 1906-7 under the auspices of the Imperial Institute. The Protectorate has now a Geological Survey, directed by Dr. F. Dixey, the energies of which are mainly directed to the exploration and prospecting of the country under a mineral survey scheme financed by a grant from the Colonial Development Fund.

The end of 1940 saw the completion of a 10 year scheme of water supply development which had been financed by grants from the Colonial Development Fund, and the 455 wells and 62 boreholes constructed under the scheme are maintained, with Protectorate funds, by the Geological Survey.

The normal functions of the Geological Survey include, however, the scientific and systematic examination of the geology of the country with investigation of its mineral resources, including building stones and the assembly and maintenance of reference collections of minerals and rocks. The results of the investigation are published and the Survey is concerned with the arousing of popular interest in the geology and mineral resources of the Protectorate. In addition, advice and guidance is provided to public departments, mining companies, prospectors and others interested in the development of mineral resources.

Sierra Leone

A Geological Survey of Sierra Leone was commenced in 1918 when Mr. F. Dixey was appointed Government Geologist. At that time practically nothing was known of the geology of the country and it had not been surveyed topographically. Mr. Dixey completed three tours between 1918 and 1921 which covered practically the whole country and was able to produce a preliminary geological map and form some idea of the general structure of the country. The economic results of this preliminary work, however, were negligible and no important deposits of any sort of economic mineral were discovered.

In 1926, at the request of the Governor of Sierra Leone for advice as to the resumption of a geological survey, Mr. Kitson, Director of the Gold Coast Geological Survey, suggested the seconding of Dr. Junner from the Gold Coast for the purpose of making a rapid survey of certain areas which Mr. Kitson considered worthy of careful examination. This preliminary examination was highly successful and in 1927 Dr. Junner was appointed Director of the new Geological Survey of Sierra Leone and was joined in 1928 by Mr. J. D. Pollett as Assistant Geologist. In 1930 Dr. Junner was transferred to the Gold Coast Survey as Director.

It was as a result of Dr. Junner's examination of the country that practically all the important deposits of economic minerals, diamonds, iron ore, gold, chromite, platinum, etc., were brought to light and developed.

As a result of these discoveries numerous requests were received from mining companies for prospecting rights, prospecting licences and mining rights. A Mines Office was opened in 1928 and the Director of the Geological Survey became also Chief Inspector of Mines with a staff of two Inspectors of Mines. Henceforth the Department became the Geological and Mines Department.

The question of Government aid to the small mine owner does not arise since, except in the case of gold and platinum, all mining and prospecting has been carried out by companies with considerable financial backing. Aid has been given to such companies, however, for in addition to the Governor exercising his power to grant exclusive prospecting licences " over large areas to corporations willing and able to bear the expense of effectually prospecting the same," direct financial aid has been given in certain circumstances, notably in the case of the loan of £500,000 in 1930 by the Government from the Colonial Development Fund to the Sierra Leone Development Co. in connection with the development of the Marampa iron ore deposits. The Governor also has power to reduce rents, royalties and other payments, e.g. railway rates, and this has been done in the case of chromite in order to aid the development of the industry.

The Geological and Mines Departments were separated in 1939. The Geologist examines and identifies many samples of rocks and minerals for the mining community annually.

TANGANYIKA

The Government of Tanganyika has in no small measure assisted the domestic mining industry by supplying adequate communications to various mining fields, by advancing money for the erection of mining plant, and by giving technical advice and reports through the Department of Lands and Mines. Transport facilities have been given to various parts of the Territory and these have made possible the satisfactory opening up of the Lupa goldfield, Lake Province (Geita mine), the Karagwe tinfield and the Uruwira goldfield.

A Geological Survey was established in the Territory in 1926, and was amalgamated in 1935 under the Government unification scheme with the Department of Lands, Mines and Survey ; the new body is known as the Department of Lands and Mines. The Geological Survey branch has steadily pursued a programme of mapping mineral areas and exploration in unmapped regions with a view to determining areas of likely mineralisation. With the assistance of the Colonial Development Fund this service has been increased and the work of the geological laboratory has been expanded to cover not only assaying for the public but also metallurgical testing of ores in order to give advice, chiefly to small workers. Bulletins or short papers, with accompanying geological maps dealing with all the existing mineral fields, have now been issued.

Following the example of Southern Rhodesia a Mining (Loans)

Scheme was instituted at the end of 1937 and a Mining (Loans) Board established which was authorised to make advances of money up to a maximum of £40,000 for the purpose of enabling lessees of mining property to develop such property and also to supply machinery on the hire purchase system. Property for which an application for assistance is made is reported on by a Government mining inspector and submitted to the Board for consideration.

After about 12 months trial, however, it was found that very few applicants could qualify, for they were not able to offer the security demanded by the conditions laid down. Many had promising probable ore, but it was not proved. The cost of opening up, necessary to turn probable ore into proved ore, was in most cases the stumbling block, though often sums of less than £500 would have sufficed. Provision in the laws was therefore made in 1939 for advances up to £500, termed pilot loans, in cases of definite promise. Even so, the difficulties involved were found to justify a complete revision of the law, and at the end of 1940 many of the previous restrictions were removed and the Board was empowered to grant loans to the holder of any mining lease or claim where, in the opinion of the Board, such assistance is desirable. The amount in respect of such claim was limited to £1,000 and similarly in the case of a lease unless it is established that payable ore of such quantity as in the opinion of the Board will provide ample security for the loan exists on any of the property of the borrower. The new provisions also considerably eased the taking of security as every loan granted constitutes by law a first charge on the property in respect of which it is made. Thus the purpose for any loan is now left to the discretion of the Board within certain financial limits.

In 1939 the Government approved the proposal to grant annually three scholarships to local youths training at the Bulawayo Technical School, after which they will return to Tanganyika to work as apprentices at several recognised mines which have agreed to take them and give them facilities for obtaining a full practical experience.

Uganda

Towards the close of the war of 1914-18 the demand for minerals necessary for the manufacture of munitions led the Colonial Office, acting in consort with the Ministry of Munitions, to embark upon a policy of geological exploration of those Empire territories which, up to that time, had received little or no systematic attention from the point of view of the discovery and development of mineral products. A Geologist was accordingly attached to the Uganda Land Office under the Director of Surveys, but, subsequently, on the Geologist's representation, His Excellency the Governor sanctioned the formation of a Geological Department. This Department, now known as the Geological Survey of Uganda, is the principal

medium through which the mining industry of the Protectorate receives Government assistance, which is normally of an indirect nature.

The work of the Survey falls essentially under two main heads, headquarters work and field work. Headquarters work consists largely of office duties in addition to chemical, mineralogical and petrological investigations in the laboratory. Here specimens are frequently identified free of charge for prospectors. Field work consists of reconnaissances, preliminary investigations of mineral areas, and detailed prospecting of proved deposits. Geological traverses are made over all mapped roads and tracks, and, together with compass traverses, over all routes taken across country.

Preliminary geological surveys are carried out when the mineral possibilities of the area necessitate it—these are essentially mineral surveys. Thus, piece by piece, evidence is being gathered for the compilation of comprehensive geological maps of the Protectorate. indeed, a provisional geological map is already in existence. In many instances the Survey has proved the payability of areas of economic value which have been granted to companies on payment of the annual licence fees alone. The Survey also assists the mining industry by means of various publications and bulletins.

The Government further assists the mining industry by granting preferential rates on railways and help in constructing roads to areas that warrant exploitation.

ABSTRACTS AND NOTES

Obituary—J. S. Coates.—We regret to record the death in London on April 11, 1941, as a result of enemy action, of John Spencer Coates, formerly Government Mineralogist and Salt Adviser, Ceylon. Mr. Coates, who was born in 1878, was educated at Rugby and Trinity College, Cambridge, where he took a first class in the Natural Science Tripos. On going down in 1900, he served in the South African War and subsequently carried out exploratory geological work in the Gold Coast from 1902 to 1903, and in Borneo from 1904 to 1906. He was appointed Geologist to the Anglo-Congolese Boundary Commission, and on completion of his term of office in 1908 was sent by the Colonial Office at the suggestion of the Imperial Institute to make a detailed examination of the soda deposits of Lake Magadi. In 1910 Mr. Coates proceeded to Ceylon, as Principal Mineral Surveyor on the Mineral Survey which had been instituted in 1902 and was being carried on in conjunction with the Imperial Institute. He became the Ceylon Government Mineralogist in 1922, and in 1924 was also appointed Salt Adviser in the island, offices which he held until his retirement in 1934.

Mr. Coates was one of those pioneer Colonial Mineral Surveyors who in the early days of the present century did so much to lay

the foundations upon which subsequent Geological Surveys were built and whose work in several instances opened the way for the development of the economic resources of hitherto unknown areas.

Topaz as a Refractory Raw Material.—Some years ago the Imperial Institute received samples of clear, water-white or slightly yellowish and iron-stained topaz of fair size and quality emanating from Nigeria as a by-product of tin washing operations. In the circumstances prevailing at that time no market could be obtained for the material, either as a gemstone, abrasive, or refractory.

It has, however, long been tacitly known that topaz, which has the formula $Al_2O_3.SiO_2(F.OH)_2$, has characteristics which might make it suitable as a refractory raw material, though no specific data has, until recently, been available on the subject. But since the announcement in 1937 of the occurrence of a large deposit of massive low-fluorine topaz in South Carolina there has been added incentive, particularly in the U.S.A., for those interested in refractories to undertake the determination of the refractory characteristics of the mineral. This has been done in a series of tests carried out by J. L. Stuckey and J. J. Amero, the results of which have recently been presented in an article in the *Journal of the American Ceramic Society*, 1941, **24** (3), p. 89, on which this review is based.

These investigations show that calcined topaz is, in fact, a satisfactory refractory material and it is hoped that the wider dissemination of these results may lead to renewed interest in the Empire source of topaz mentioned above.

The Carolina deposit of topaz was discovered in the course of stripping operations at an auriferous placer deposit at the Brewer mine in Chesterfield County which was described by Pardee, Glass and Stevens in the *American Mineralogist*, 1937, **22** (10), p. 1058. The occurrence *in situ* extends over an area about 25 ft. wide by 50 ft. long, but considerable extensions to this are indicated by the presence of "float." Samples of the rock taken intermittently in a 400 ft. adit frequently exceed 90 per cent. topaz, the average specific gravity of which is 3·509. Chemical analyses of the topaz show that it possesses the lowest fluorine and highest water content of any topaz known.

Samples of the topaz, dried at 110° C. and ground to pass a 65-mesh Tyler sieve, were heated in alundum crucibles at 100° C. intervals to between 200° and 1,600° C. The temperature was maintained in each instance as nearly constant as possible for 10 hours. Most of the fluorine and water were driven off between 850° and 900° C., but with the volatilisation of the fluorine some of the iron and a considerable amount of silica were carried off. The colour was buff to pale brown up to 850° C., but fired to a pure white at 900° C. and higher.

The mineralogical change accompanying this loss of the fluorine and water content is indicated by the presence of mullite as the

principal constituent together with a little cristobalite at 1,100° C., whilst at 1,500° C. the topaz was practically entirely changed to mullite. The pyrometric cone equivalent of this topaz is 40, whilst the thermal expansion is stated to be small, amounting to 1·210 per cent. at 1,200° C. The permanent expansion, 0·758 per cent., constitutes a large part of the total expansion.

Varying proportions of this topaz were added to flint-fireclay refractory compositions and their effect investigated. In general, the effect was to raise the P.C.E., reduce the firing shrinkage, and increase the resistance to deformation under load, though the spalling loss, especially with those mixes containing the highest proportion of topaz and those containing certain mesh-sizes of the ground topaz, was increased, a tendency which might be offset by precalcination. From these investigations the authors conclude that this material should be particularly useful for the manufacture of electrical porcelain such as is employed, for instance, in the bodies of sparking plugs.

The Solvent Extraction of Coal by Tar-Oils.—The first of the new series of research bulletins emanating from the University of Birmingham Mining Department contains an account of preliminary work on the action of tar-oils on coal carried out by R. W. Tebbett, S. G. Ward and J. G. Weighall in the Coal Utilisation Research Laboratories.

Many substances, especially phenol and pyridene, and benzene and tetralin under pressure, are known to have a powerful solvent action on coal, and the solvent action of tar-oils has already been demonstrated by workers in Spain and Belgium. Little was known, however, of the action of tar-oils on British coals, and this research was undertaken to determine, *inter alia*, the possibility of substantially de-ashing coal by this means, the possibility of making new products, and the effect of tar-oils on the coking properties of weakly-caking and other coals.

The extractions were carried out on a modified Soxhlet principle at temperatures ranging from 170° C. to 400° C. in an atmosphere of nitrogen, and the extracted material was precipitated from solution with petroleum ether.

It was found that coals pass into solution or pseudo-solution in neutral tar-oils at their boiling point under atmospheric pressure and that, under certain conditions, practically ashless materials derived from the coal can be recovered from the solutions.

In nearly every extraction made the sum of the products collected exceeded 100 per cent. of the weight of coal used—and the products collected do not include gas, water, or extracted material soluble in the mixture of tar-oil and petroleum ether. It appears that the discrepancy, generally speaking, is greater at the higher temperatures and that, at these higher temperatures, it is greater for the coking than for the non-coking coals used. The discrepancy

may be due to the sorbtion of oil by the coal residue, or the presence in the precipitated extract of materials derived from the oil or ether. It is clear, however, that (apart from temperature and time) it is a function of both the oil and the coal used, since under the same conditions and using the same oil, different coals give widely different discrepancies, and by " salting " an oil with a small amount of coal or its extract, and subjecting it to as nearly as possible the same thermal treatment as in the extraction experiment, one does not always obtain petrol-insoluble material in such proportions as are given by, for example, the difference between the petrol-insoluble product and the loss in weight of a coal in a comparable experiment with the same oil.

The amount of extract obtained by treating the same coal with neutral tar-oils from different stock but of the same boiling range is not necessarily the same, which indicates that the action is not simply a function of temperature, but that it depends also upon the composition of the neutral oils.

When tar-oils containing their natural tar-acids and bases are used it appears that the discrepancy between the loss in weight of the coal and the yield of petrol-insoluble material is decreased and the solvent action of the tar-oil is improved.

That the coal-residues may contain sorbed oil after treatment is shown by the fact that, even after exhaustive extraction with benzene followed by drying in vacuo, the weight of the coal residue at the lower temperatures used frequently exceeds the original weight of the coal treated. This sorption was greater for the non-caking than for the caking coals used.

The following list summarises some of the more important uses to which tar-oil coal-extracts (or their solutions in tar-oils) might possibly be applied :

1. The extracts, or parts of them, might be used to improve the caking and swelling properties of non-caking or poorly-caking coals.

2. They may be used as binding agents in the manufacture of briquettes.

3. They can be so treated as to yield a pitch-like material containing little or no "free carbon," and this material might, for some purposes, be a more useful substitute for bitumen than ordinary coal-tar pitch.

4. Coal-extract solutions, distilled to yield a hard pitch, may be pulverised to provide a powdered fuel of very low ash content which might be used for special purposes, e.g. in the coal-dust engine, or for certain processes where a low ash fuel is necessary.

5. The extracts may be used in the preparation of " colloidal fuels."

6. They may be useful in modifying the properties of ordinary coal-tar or in the preparation of special tars.

7. After proper treatment they may be made to yield special low ash carbon, or even graphite.

8. They may be treated to yield pure compounds of value, e.g. in chematherapy.

9. Coal-extracts, or material precipitated from their solutions may, after suitable treatment, yield useful fillers for certain processes.

Electrostatic Separation of Phosphates in Florida.—Phosphate is a low-priced mineral and in view of the fact that material with a minimum content of insoluble matter sells at a premium, usually based on the tricalcium phosphate (B.P.L.) content, producers naturally aim at obtaining a high-grade product. In the past, therefore, the flotation plants in Florida have been operated primarily with the object of producing high-grade concentrates rather than for high phosphate recovery. Latterly, however, after much preliminary research, an electrostatic process has been successfully applied in conjunction with flotation at a plant operated by the American Agricultural Chemical Company, with the result that a considerably higher recovery of phosphate from the matrix is being obtained. An account of the advances made in phosphate recovery at this plant is contained in an article by H. B. Johnson who was mainly responsible for the design of the process employed (*Engng. Min. J.*, March 1941, pp. 35-38).

Preliminary investigations indicated that it would be possible to increase phosphate recovery in the flotation process from 80 per cent. to 90 per cent., that the flotation plants could therefore be operated for maximum recovery instead of grade, and that the control of grade could be achieved by electrostatic means. It was envisaged that the increased recovery would offset to a considerable extent the cost of electrostatically refining and controlling the grade. It was also foreseen that the electrostatic separation of the Fahrenwald sizer products, increasing the grade from 60/65 per cent. to 70/73 per cent. tricalcium phosphate, would permit direct mixing of the static concentrates produced from the Fahrenwald products with the higher grade static concentrates produced in refining flotation concentrates thereby increasing the output of phosphate per ton of mineral mined. In addition, the storage problem involved in handling flotation concentrates of grades varying from 71 to 75 per cent. tricalcium phosphate could be simplified by feeding them to the static plant and producing a constant 77 per cent. concentrate. Finally, as the drying cost is not chargeable to the static refining cost, since concentrates have to be dried before shipment, it was considered that the operation should be profitable if the grade could be improved by at least 3 per cent. tricalcium phosphate and a recovery of 99 per cent. of the flotation concentrates obtained.

In the method adopted, flotation concentrates discharged from the dryers were passed over a screen where the over 10-mesh phosphate, trash, etc., were removed. The material was then passed to four Johnson-process electrostatic separators each with a capacity of 10 tons per hour, the concentrates going to a 600 ton static

concentrate storage bin. About 12 to 15 per cent. of middlings were produced which were returned to the head feed. The rough tailing, composed of silica and phosphate particles which had had the flotation reagents burned off in the drying process, was passed to another electrostatic separator for secondary treatment. The tailing from this operation contained from 6 to 12 per cent. tri-calcium phosphate.

The separators are designed so that an even feed passes between the electrodes. The feed rolls are 8 ft. in length and the number of electrodes used controls the grade of concentrates.

In the treatment of flotation concentrates a representative result showed an increase in phosphate content of from 2½ to 5 per cent. with a total recovery of 99 per cent. In the treatment of Fahrenwald products the following results were obtained.

Head Feed.		Concentrates.	
B.P.L. *Per cent.*	Insol. *Per cent.*	B.P.L. *Per cent.*	Insol. *Per cent.*
63·02	17·64	72·65	4·55
60·52	20·11	72·33	4·34
62·00	18·31	72·31	4·43

The separating cost worked out at about 15 cents per long ton of feed and the writer expresses the opinion that there is little reason why a tonnage of 25 to 200 tons per hour could not be handled economically.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

MATERIALS HANDBOOK. An Encyclopedia for Purchasing Agents, Engineers, Executives and Foremen. By George S. Brady. Fourth Edition. Pp. vii + 591, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 35s.

The *Materials Handbook*, of which this is the fourth edition, is one of the most comprehensive and useful works of reference on industrial materials available. It is the result of twenty years work and is compiled from data collected during the period when Mr. Brady was American Trade Commissioner in various foreign countries and later when he was managing editor of two industrial trade papers. The author therefore has first-hand experience of the requirements of trade and industry and of the kind of information needed in a work of this nature. As he points out in his preface, it was not his intention to provide an exhaustive treatise on any material; he has, however, been most successful in collecting and collating a great deal of useful general information on many raw materials and their products.

The subject headings are arranged alphabetically and include raw materials of all kinds both organic and inorganic employed in industry, and a great variety of manufactured products such as metals, alloys, plastics, building materials, industrial chemicals, etc. Materials used as foods and drugs, the farmers' raw materials, fine chemicals and essential oils are not dealt with. Mentioned under each subject are the more important sources of the material, the grades in which it is marketed, its properties and uses, and where appropriate the secondary products derived from it. A particularly valuable feature of the book is the inclusion of a large number of American trade names of proprietary products together with the names of the companies by which they are manufactured.

Considering the scope of the work the inaccuracies are not numerous, and the book compares rather favourably in this respect with other similar compilations, some of which are notoriously unreliable. As seems usual in this type of work, botanical names form the chief stumbling block, and it would be a good thing if the publishers would insist on the proofs being checked by a botanist.

The Appendix, consisting of 23 pages, contains some useful tables of data including comparisons of the metal gauges in common use, and of Rockwell, Scleroscope and Brinell hardness numbers. Some idea of the comprehensive nature of the work can be gathered from the fact that the index contains over 4,700 items.

The *Materials Handbook* will be found a most useful addition to any reference bookshelf.

GEOPHYSICAL PROSPECTING FOR OIL. By L. L. Nettleton. Pp. xi + 444, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 35*s*.

The known reserves of oil in the world are being used up with great and increasing rapidity; in fact if no new resources came to light the United States fields would be exhausted in perhaps ten or fifteen years time. As the rate of depletion grows the search for new fields and for extensions of old ones becomes ever more intense and has now to be carried on in areas where geologists have no visible surface clues to aid them in determining whether rock structures favourable for the accumulation of oil exist at depth. For this reason in the last decade or so geophysical prospecting methods have been employed in most of the likely areas in an endeavour to look below the surface and provide clues to the nature of the underlying rock structures. The success already attained is indicated by the fact that 29 per cent. of the additional oil reserves discovered in the United States from 1922 to 1938 were located by this means. Geophysical prospecting, however, does not find oil; it is a branch of applied physics, and the purpose of a geophysical survey is to produce a map (the nature of which will depend upon the method employed) showing indications of the subsurface contours, local anomalies and other data upon the correct interpretation of

which depends the ability to form a picture of the structures in the rocks below. The successful application of geophysical methods, therefore, involves an accurate understanding of one another's needs and limitations by geophysicists and geologists. Unfortunately however, the sciences of physics and geology are studied as a rule by individuals of different mental types, and it is unusual to find a geologist who is able to comprehend thoroughly the methods and results of the geophysicist, or a physicist who is also a competent geologist.

The express purpose of this book is to present in as clear a light as possible the elements of geophysical prospecting, particularly as applied to oil-seeking, for the benefit of the student or "lay-reader," presumably meaning oil-geologists and engineers. Although the mathematics has been reduced to a minimum and simplified, it must be admitted that much of it will be found very difficult for most geologists, nevertheless the book provides the most readable and generally understandable account of this very difficult subject yet published.

Commencing with an admirably brief and lucid introduction, the book consists mainly of three sections in which are described in detail the three methods of carrying out geophysical surveys, gravitational, magnetic and seismic, in that order, and concludes with an outline of electrical surveying and oil-well logging, and with a brief chapter on geophysical interpretation. Each subject is dealt with in much the same way; first a discussion of first principles, then a description of the instruments employed, followed by methods of making observations and calculations, and the interpretation of results. To each main section is appended a bibliography of the subject dealt with.

The utility of gravity gradient surveying is clearly indicated as being small except in areas of very much simplified tectonic structures and even then is severely limited for practical purposes by the small differences in rock density usually characterising such areas. Magnetic surveying is of equally limited use in oil-prospecting since the igneous rocks alone show sufficient magnetic susceptibility to afford reliable results. The most constructive field work, however, appears to have been done by seismic methods, and, particularly since the author's mathematical treatment of this subject is relatively simple, the geologist will find the section devoted to seismic methods of oil-prospecting entertaining and instructive reading.

Electrical prospecting methods including oil-well-logging receive rather brief treatment because of the limited utility of electrical methods in prospecting for oil, except at very shallow depth.

The final chapter on geophysical interpretation is much too short; it actually tells little about how the map is to be interpreted and gives no examples whatever. It does, however, emphasise the need for co-operation to take the place of wrangling between geophysicist and geologist.

This excellent text-book should go a long way towards dispelling the geologists' ignorance of the basis of geophysical work, and may help to bring forth that hybrid offspring of the sciences for which the author hopes.

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EXHIBITION GALLERIES, FILM LIBRARY AND CINEMA

NOTES

Exhibition Galleries.—Although the Exhibition Galleries continue closed to the general public, they are open by special arrangement either to private individuals or to organised parties. Distinguished visitors during the past quarter have included the following names:

On July 3 Sir Gilbert Wiles, K.C.I.E., C.S.I., I.C.S., formerly Chief Secretary of the Government of Bombay (Political Services Department), and now Adviser to the Secretary of State for India, was shown the Indian Court by the Director.

On July 21 Lady Harlech accompanied the Director on a tour of the South Africa Court previous to her departure for South Africa to join Lord Harlech, High Commissioner for the United Kingdom in the Union of South Africa.

On July 24 Sir Douglas Jardine, K.C.M.G., O.B.E., formerly Governor of Sierra Leone, and now Governor-designate of the Leeward Islands, visited the West Indian and West African Courts.

On July 29 Sir Alan Burns, K.C.M.G., formerly Governor of British Honduras and now Governor-designate of the Gold Coast, was shown the West Indian and West African Courts by the Director.

On August 13 Lady Cochrane, wife of the ex-Governor of Burma, visited the Institute and was taken by the Director to the Burma Court to see the latest improvements to the Court.

The following organised parties have made tours of different sections of the Galleries during the past three months and on these visits have been conducted either by the Director or the Guide Lecturer. In most cases the tours of the Galleries were followed by visits to the Cinema where related films were shown.

On June 6.—A party of members of the Association of Polish Engineers, by arrangement with the British Council.

On June 8.—A unit of the Indian Pioneer Corps.

On June 20.—A party of members of the Association of Polish Engineers.

On June 21.—A party of Czechs and Belgians from the Surbiton Women's Volunteer Service.

On June 30.—A party of children from the Gibraltar Evacuee School.

On July 4.—A party of members of the Association of Polish Engineers.

On July 11.—A party from the Ickenham High School.

On July 14.—A party of children from the Gibraltar Evacuee School.
On July 18.—A party of members of the Association of Polish Engineers and a party of pupils from Bishopshalt School, Hillingdon.
On July 21.—A party of children from the Gibraltar Evacuee School.
On July 22.—A party of officers of the Royal Artillery Depot, Woolwich.
On July 23.—A second visit by officers of the Royal Artillery Depot, and a party of boys from Wimbledon College.
On July 24.—A third visit by officers of the Royal Artillery Depot, Woolwich.
On July 25.—A party of members of the Association of Polish Engineers.
On July 26.—A party of evacuees from Gibraltar.
On July 31.—A party from Henry Thornton School.
On August 11.—A party of members of the Institution of the Rubber Industry.
On August 12 and 14.—Parties of officers of the Royal Artillery Depot, Woolwich.

New Exhibits.—A new Colonial Empire Court has been formed in a central position in the South Gallery in front of the Publications Stand. In the centre of this Court is situated the large illuminated Colonial Empire products map described in this BULLETIN, 1939, **37**, 318. Under the title "Life in the Colonial Empire," enlarged photographs, illustrating life and activities in the different Colonies and Dependencies are being collected and arranged in the following groups: Mediterranean, Ceylon, Malaya, Far East, Pacific, Indian Ocean, East Africa, West Africa, Atlantic and West Indies. The groups, not yet complete in every case, are exhibited, five on one side and five on the other side of the Court, in Stillograph machines. A group when complete is represented by eleven photographs, each picture being displayed and illuminated by the machine for about seven seconds and then automatically giving place to another picture, two photographs being displayed at a time in each group. Of the total of 110 photographs required for the complete scheme, 67 are now on exhibition. Others will be added as suitable pictures become available. The Stillograph machines were formerly the property of the Colonial Empire Marketing Board and were transferred to the Exhibition Galleries after exhibition in the Colonial Hall in the British Pavilion at the World's Fair, New York, 1939-40, the original sets of photographs displayed in them having been presented to the British Library of Information in New York.

Adjacent to the groups of Stillographs are two Informograph machines. These are operated by pressing buttons bearing numbers corresponding to numbers on an illuminated index card. In one

of these machines are displayed charts descriptive of the various countries which comprise the Colonial Empire ; in the other machine the staple colonial products are described and pictured.

Two additional Stillograph machines exhibit the Imperial Institute sets of photographic cards illustrating important industries in the Colonial Empire.

A coloured map of the Colonial Empire, presented by *The Crown Colonist*, is also exhibited in this Court. This map, in addition to setting out clearly the whole Empire in its world setting, shows each of the Colonies inset in greater detail.

Subsequent to rearrangement effected in India House to meet the exigencies of the war, the High Commissioner for India has transferred the following dioramas to the Imperial Institute for the duration of the war. They have been cleaned, renovated, and, where necessary, repaired, and are now installed in the Exhibition Pavilion adjacent to the Cinema. Most of them were constructed in the Imperial Institute studio by the Imperial Institute artists, but a few others were made elsewhere and are, therefore, seen in the Imperial Institute for the first time. Altogether they form a colourful extension to the Indian Court. The dioramas represent the following subjects :

A Tea Garden in Assam.
A Coffee Estate in Southern India.
A Jute Mill on the Hooghli.
Carpet-making in Northern India.
A Modern Match Factory in the United Provinces.
Hydro-electric Power in the Punjab.
The Sukkur Barrage on the Indus.
The Tata Iron and Steel Works, Jamshedpur.
The Kolar Gold Fields, Mysore.
Coal-mining at Parbelia Colliery in Bengal.
The Port of Bombay.
The Port of Calcutta.
The Port of Karachi.

For the Mauritius Court a new diorama has just been completed to illustrate the sugar industry of the Colony. This diorama is the work of Mr. Ernest Whatley and is based on an album of photographs sent for the guidance of the artist by the Colonial Secretary in Mauritius. The cost of the diorama has been met through the courtesy and generosity of the Sugar Industry Reserve Fund Committee of Mauritius.

The diorama shows the planting, the growing cane, the harvesting operations and the ploughing of old fields for new crops with a typical Mauritius landscape as background. A reproduction of a photograph of the diorama appears as Plate II.

The descriptive label attached to the cabinet containing the diorama reads as follows :

PLATE II.

SUGAR-CANE FIELDS IN MAURITIUS.

Reproduced from a Diorama in the Mauritius Court, Exhibition Galleries, Imperial Institute.

facing page 313]

Mauritius

The Story of Sugar-cane Cultivation

" Introduced into Mauritius during French occupation in the eighteenth century, sugar-cane has long been the staple crop, and in recent years sugar has accounted for more than nine-tenths of the total value of the Island's exports.

" With an area of only 720 sq. miles, about equal to that of the English county of Berkshire, Mauritius has a dense population of nearly 550 persons per sq. mile, 67 per cent. being Indian immigrants or their descendants.

" It is sugar which provides the majority of Mauritians with their chief means of livelihood, but this concentration on one crop naturally involves the importation of large quantities of foodstuffs from abroad, chiefly from India and Australia.

" In this diorama is shown a typical Mauritius scene, the skyline of rugged mountains of volcanic origin being a characteristic feature of the landscape. The foothills of the mountains, and the low level areas, such as are seen in the centre of the picture, are devoted to the sugar-cane crop.

" On the right a tractor is at work ploughing up an old cane-field for replanting, and to the left the planting of sugar-cane cuttings is in operation.

" Workers are seen in the distance bringing in baskets of manure to be placed in the furrows which are to receive the cuttings, and on the extreme left are seen furrows which have been planted and mulched with trash to protect the cuttings until they take root.

" In the immediate foreground on the left is a growth of young cane whilst on the right is mature green-stemmed cane ready for harvesting. In the centre is a bullock cart laden with a red-stemmed variety from another field; the canes are being transferred by hand to the trucks on the estate railway for conveyance to the factory seen in the distance.

" The green leafy tops of the cane are removed and serve as cattle fodder. Women with head loads of this material for their domestic animals are seen in the distance making their way to their homes on the extreme left.

" Sugar from Mauritius, averaging about 248,000 tons annually, is exported chiefly to the United Kingdom."

The reorganisation of the Cyprus Court has been continued. In spite of the difficulties surrounding the shipment of goods from the Mediterranean region, a small consignment of some of the promised exhibits has been received from Cyprus through the Director of Agriculture, and these have now been incorporated in the Court.

The olive display has been improved by fresh supplies of unrefined and refined olive oil. For a cotton display a series of exhibits has been received, consisting of a beautifully executed life-size

detailed drawing and a water-colour sketch of a cotton plant in bloom, together with a number of photographs of cotton buds, flowers and bolls and specimens of ripe bolls, seed-cotton and cotton lint. The drawings will later be used as the basis for the construction of a full-sized model of a cotton plant.

Similar drawings of tobacco have also been received, and these, too, will be utilised for a life-size model of a tobacco plant. Other tobacco exhibits received consist of a set of photographs depicting tobacco cultivation, harvesting and drying, and a sample of dried tobacco leaves.

A detailed pencil drawing and a water-colour sketch of a carob spray showing the green pods has also been received and will be associated with the model of a spray already made and exhibited in the Court.

The native handicrafts display has attained new interest from a set of local wood carvings comprising a fruit bowl and salad tongs, a postage stamp box, a cigarette box following the design of a characteristic Cyprus chest, and miniature replicas of a camel and rider, a man threshing with a pair of donkeys, and two mouflons, the local wild sheep which are now very scarce in Cyprus and are strictly preserved.

Amongst other improvements to the Australian Court a series of six model relief maps of Australia has been renovated and rearranged. These maps show respectively (1) rainfall, (2) artesian basins, (3) the wheat belt and winter rain, (4) sheep pasturage, (5) cattle pasturage, and (6) utilisation of all land area ; they have been cleaned and where practicable recoloured, and the sea area has been painted a broken white in order to give prominence to the land. Descriptive labels are in preparation to explain the maps.

Empire Lectures to Schools.—In the Report on the Imperial Institute Scheme for Empire Lectures to Schools published in the previous issue of this BULLETIN (1941, **39**, 203), it was stated that the scheme would be terminated at the end of March, but the hope was expressed that funds may be made available from private sources to enable the scheme to be resumed during wartime. It is now possible to announce that through the generosity of the Leverhulme Trustees the lectures are to be continued during the current year as from September. In this connection the following article by Sir Harry Lindsay, Director of the Imperial Institute, appeared in *The Times Educational Supplement* for August 9, 1941 :

EMPIRE LECTURES TO SCHOOLS

An Imperial Institute Service

" One of the functions of the Imperial Institute is that of telling the story of the Empire, its life, scenery, industries and the ideas and ideals for which it stands to the general public and particularly to the rising generation of this country.

" This it does by various methods. There are the Exhibition Galleries which are divided into Empire Courts representing each country of the oversea Empire. Here, as well as in the Cinema Hall, where in peace time Empire films were shown every morning and afternoon, many thousands of school children, with the help of guide lecturers, found the atmosphere of the Dominions and Colonies. Even in war-time school parties come by special arrangement. Then there is the Central Film Library, of which the Empire section circulates films of the Empire to schools and societies throughout the United Kingdom. The films are circulated without charge, and when it is remembered that over one hundred and fifty films are dispatched and received every day it will be realised how wide an audience is reached by this means—an audience running into many millions each year.

" As the result of war conditions lectures on the oversea Empire are no longer given in the Cinema Hall of the Institute. Instead, a panel of Empire lecturers has been organised each of whom has had personal experience of the oversea countries which constitute the British Commonwealth of Nations. Education officers have been asked to interest their schools in this scheme and a large number of schools have applied for the services of the Empire lecturers, services for which no charge is made either to the educational authority or to the school. The scheme was initiated in the middle of June, 1940, and began in a small way in the principal urban centres in the Midlands and North of England. But other schools heard of the scheme, and as the number of Empire lecturers on the panel increased it has been possible to extend this service to secondary schools in many parts of England and Wales.

" The original grants, which enabled the Imperial Institute to meet the expenses of lecturers, came to an end in March 1941. By that time nearly 400 lectures had been given to audiences aggregating nearly 60,000 school children. The continuance of the lectures during the current year has now been made possible by a grant from the Leverhulme Trustees. Education authorities and schools have been approached again, lecturers have been asked to rejoin the panel; already applications for 65 lectures have been received and the scheme will reopen in September.

" The Institute is in touch with some 250 secondary schools in England and Wales, and education officers who have not yet heard of the scheme and are anxious to obtain particulars about it should apply to the General Secretary, Imperial Institute, London, S.W.7. The areas in which lecturers are available are: London, Middlesex, Surrey, Kent, Hertfordshire, Buckinghamshire, Berkshire, Hampshire, Sussex, Dorset, Somerset, Devon, Worcestershire, Gloucestershire, Nottinghamshire, Herefordshire, Cheshire and Lancashire. Mr. Harcourt Johnstone, M.P., Secretary of the Department of Overseas Trade and President of the Board of Governors of the Imperial Institute, has taken a personal interest in the scheme

and it is his encouragement and support, backed by the generous donation received from the Leverhulme Trustees, that has made it possible to put the scheme on a sound footing."

Cinema.—At the request of the Burma teak shippers a film of the Burma teak industry is being put together from material supplied from Burma. It has been decided that the film will be presented in three parts, (1) Extraction of Teak, (2) Milling of Teak, and (3) Utilisation of Teak. A good deal of time has been devoted to the first part, which is nearing completion, and the second part, which deals with the milling of the timber, is in hand, after which the utilisation of teak will be dealt with.

On Monday, August 11, members of the Institution of the Rubber Industry visited the Cinema and witnessed a display of films dealing with the rubber industry. They afterwards inspected exhibits in the Galleries, illustrating developments of the industry in the Colonies which produce rubber.

Central Film Library.—During the Film Library year ending August 31, 1941, there have been in circulation about 560 different films. Of these 400 form the Empire section of the Library, 60 the G.P.O. section, and 100 the Ministry of Information. Varying numbers of copies of these films are held in the Library, ranging from 2 or 3 copies of the more specialised films to as many as 24 of some of the more popular Ministry of Information films.

During the year 50,000 prints of the films have been despatched to borrowers. Of these 27,000 were Empire, 5,000 G.P.O., and 18,000 Ministry of Information.

The requirements of borrowers vary considerably. Some borrow one or two films at a time, others borrow a complete programme. Some borrow the films for showing to four or five different audiences on consecutive days; others borrow the films for showing to single audiences. Some show the films to audiences of 40 to 100; others show them to audiences of 500 to 1,000. On an average each film sent from the Library is shown to three audiences, each averaging 100 to 150 people. In all about 4,000 individuals and organisations are now borrowing films from the Library.

A general analysis of borrowers shows that they can be divided into the following six categories:

1. Adult education organisations, including churches and voluntary clubs, such as Y.M.C.A.
2. Factories and business houses.
3. Civil Defence Units.
4. Service Units and A.T.C. Squadrons.
5. Individuals giving shows to the public. (Most of these are school teachers, clergy, amateur ciné enthusiasts.)
6. Schools.

Preparations are now being made for the new season beginning September 1, 1941. It is already known that more than 50 new films will be added to the Library by the Ministry of Information before the end of the year. These will include a number of important films about Empire countries at war, and a number of instructional films on important topics in health, education, food and gardening.

A revised edition of the Empire Section of the Central Film Library Catalogue has just been issued. Many new subjects have been added to the Library and some of the more out of date films have been withdrawn.

The Institute is grateful to the High Commissioner for Canada for the presentation of a number of prints of films which will replace those which had been withdrawn from circulation owing to wear. Thanks are also due to the Queensland Cane Growers Council and to the Port of London Authority for the presentation of copies of new films.

Empire Lantern Slide Library.—The circulation of lantern slides of the Empire to schools, women's institutes, societies and army educational authorities during the period May, June and July is shown in the following table:

	May.	June.	July.
Australia	150	150	—
Canada	—	150	150
New Zealand	50	50	—
South Africa	100	100	—
India	250	150	200
Burma	100	—	100
Territories of the Colonial Empire	550	600	250
Products of the Colonial Empire	150	250	—
General Tours of the Empire	500	200	50
History of the Empire	—	—	100
	1,850	1,650	850

The reduction in circulation is obviously due to the effect of double summer time and the reluctance of people to stay indoors during hot weather with windows shut and blacked out.

A new picture talk on "Cyprus: Yesterday and To-day," written by Mr. St. John Wayne, Commissioner for Cyprus, has been printed. The talk begins with a short description of the geographical features of the Island, its antiquities and ancient history, the conversion of its people to Christianity, and subsequently its position as the most easterly outpost of Christendom. Mr. Wayne surveys the commercial and political importance of Cyprus during the Crusades, its conquest by Richard Coeur de Lion, and the period under the Lusignan Dynasty and the Venetians when Cyprus acquired its many churches and castles. Later it was conquered by the Turks who converted some of its churches into mosques. The historical survey is followed by a description of present-day Cyprus,

its people, vineyards, tobacco plantations, the crops it produces, its harbours and export trade.

A new talk on Ceylon has been written by Mr. R. B. Naish, Ceylon Civil Service, and has also been printed. After a short historical introduction, a tour is made of Ceylon, stressing the relation with Southern India and the importance of Colombo Harbour as a sort of Clapham Junction for sea traffic to and from the East. The types of people living in Ceylon are illustrated, their religions, beliefs, ceremonies and architecture, the way they get their living in the rice, rubber, tea and coconut industries or by fishing, and finally Mr. Naish describes the wild animals of Ceylon.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the period May-July 1941.

MAY 1941

T. HIRST, Senior Geologist, Geological Survey, Gold Coast.

JUNE 1941

Nil.

JULY 1941

Sir ALAN C. M. BURNS, K.C.M.G., Governor, Gold Coast.
Sir DOUGLAS J. JARDINE, K.C.M.G., O.B.E., Governor, Leeward Islands.
H. W. NIGHTINGALE, Colonial Administrative Service, Malaya.
J. N. OLIPHANT, C.M.G., Chief Conservator of Forests, Nigeria.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

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CALLING THE WEST INDIES

A Broadcast Interview with Sir Harry Lindsay, K.C.I.E., C.B.E., transmitted to the West Indies on November 30, 1941, and reproduced by courtesy of the British Broadcasting Corporation.

MISS MARSON : Sir Harry, it's nice to meet you again. I remember how much I learnt about many parts of the Empire from you when I first came to this country and visited the Imperial Institute. Tell me, how long have you been Director ?

SIR HARRY LINDSAY : Seven years, Miss Marson. I was appointed Director here when I retired from the Indian Civil Service in 1934.

MISS MARSON : When did you make up your mind to go out to India ?

SIR HARRY LINDSAY : As a matter of fact, Miss Marson, India figures very largely in our family, for my father was a banker in India and my grandfather and great-grandfather were both in the Indian Army. I was born in Burma, so it was quite in the family tradition that I should try for the Indian Civil Service. I spent eighteen years out there altogether—followed by twelve years in London as the Trade Commissioner for India.

MISS MARSON : And when you retired from that position you came to the Imperial Institute ? What prompted you to take up this work ?

SIR HARRY LINDSAY : Well, Miss Marson, I had always been interested not only in India, but in the problems of the Overseas Empire. I had made many friends in the Dominions and Colonies whom I had met in London at Imperial Conferences and on other occasions.

MISS MARSON : Well, Sir Harry, I'm sure you are the right man in the right place—and that leads me on to the work you have been doing. Could you please tell me just a little about the Imperial Institute itself ?

SIR HARRY LINDSAY : That is a pretty big question, and I hardly

know where to begin, or, indeed, when and where to stop once I have begun.

MISS MARSON: Well, I think I can help you. Let us begin at the very beginning. What is the primary object of the Institute?

SIR HARRY LINDSAY: In a nutshell, the Institute is a centre of information about the Empire—not only about the Dominions, but about every single Colony of the Empire and even the Dependencies and Mandated Territories. It is our primary object to serve them all, and particularly to furnish them with the scientific and technical information they require for the development of their natural resources. In fact, we claim to be the only centre which specialises on raw material development, whether animal, vegetable or mineral. And secondly, by means of the Empire Courts in our Exhibition Galleries, our films, lectures and other services, we tell the story of the Overseas Empire to the general public of the United Kingdom.

MISS MARSON: And how long has the Institute been carrying on this work?

SIR HARRY LINDSAY: For just over fifty years, for we were founded in 1887 as a memorial of the Golden Jubilee of Queen Victoria of happy memory.

MISS MARSON: Well, that's a long record.

SIR HARRY LINDSAY: Yes, indeed, I do not think it is any exaggeration to say that at one time or another in our fifty years every single raw material of any commercial importance has passed through the hands of this Institute.

MISS MARSON: What exactly do you mean, Sir Harry, by passing through the hands of the Institute?

SIR HARRY LINDSAY: It means that we have, over all these years, studied in our laboratories and intelligence offices, and also in scientific journals, both British and foreign, all that there is to be known about the science of raw materials—their production, processing, marketing, utilisation, etc. It is not a mere matter of tabulating other people's discoveries, though we must certainly do this in order to keep up to date. It is also a matter of carrying out detailed examinations of actual products sent to our laboratories from all countries of the Empire. Thus, we are not merely a bureau of reference, but we ourselves discover and furnish much of the information required.

MISS MARSON: Who are the people who usually send you these inquiries?

SIR HARRY LINDSAY: They are of very wide range. They may be the Governments themselves, or else they may be producers or merchants or manufacturers. We attend to all the inquiries we receive but, of course, they must relate to the encouragement and development of the material resources of some country within the British Empire.

MISS MARSON : Well, I expect you must have a highly trained staff to deal with these inquiries ?

SIR HARRY LINDSAY : I'm very glad indeed of this opportunity to pay a tribute to the highly-qualified, energetic and loyal body of scientists who assist me on this side of my work—both men and women. They number about 40 in ordinary peace-time, but, of course, the number is much reduced in war-time, for about half of this staff is either serving with H.M. Forces or else on special duty in connection with the war effort. In the prosecution of the war effort their scientific knowledge and experience are of great value.

MISS MARSON : I'm sure of that, Sir Harry. Now that I've got that part of your work clear in my mind, shall we come down from the general to the particular ? What about your scientific and technical work for the West Indies ? Is there much that you are able to do to help them ?

SIR HARRY LINDSAY : We have had a long connection with the West Indies and given them quite a lot of help from time to time. For example, as regards paper-making materials. Our laboratory is equipped with the latest apparatus. This enables us on a small scale to find out how a new wood, for example, will respond to treatment in a commercial paper mill and also to determine the kind and quality of the paper produced from it. One of the most interesting of these products from the West Indies that we have examined is Wallaba wood from British Guiana. We have been able to advise the Colonial Office regarding proposals to develop the Wallaba forests of that Colony.

MISS MARSON : And I suppose different parts of the Empire help each other through you ?

SIR HARRY LINDSAY : Yes. Another inquiry I should like to mention shows how the Institute acts as a sort of clearing house for information between the West Indies and other parts of the British Commonwealth. The Department of Agriculture in Trinidad was proposing to open up certain areas of swamp land for rice growing, but owing to their proximity to the sea there was a chance of the land becoming salty. The problem was to find varieties of rice that would be tolerant of salt. We were consulted in the matter and from our knowledge of rice growing in other countries were able to arrange for seed of a large number of different kinds of rice to be sent from India, Burma, Ceylon, Hong Kong and Sierra Leone for trial in Trinidad. The people in these places also furnished particulars of the methods they employ for growing the rice.

MISS MARSON : Thank you, Sir Harry, those are two very clear and important examples of the assistance you are able to render to the West Indies in paper-making and in rice-growing. That reminds me that nutrition problems are very much to the front just now. Are you able to help with them ?

SIR HARRY LINDSAY: Yes, the question of the nutrition of the local population is as important in the West Indies as in other parts of the Colonial Empire. We have supplied information to many of the Governments there on such subjects as the drying of fish, the composition of local foods, and the incorporation of vitamins in locally-made margarine, among others. Then again, as regards the establishment of new industries, we gave British Honduras assistance some years ago in starting the manufacture of cassava starch and more recently helped the Jamaica authorities in the same direction.

MISS MARSON: And what about mineral developments? These are particularly important in war-time, are they not?

SIR HARRY LINDSAY: Very much so, Miss Marson. I fear I cannot mention any of our special war work in the sphere of minerals, but I can mention a few instances where we have helped the West Indies in general minerals development. For example, the possibility of making Portland Cement in the West Indies has often been considered in recent years, and the Institute has been able to assist by supplying information concerning raw materials available locally. The production of cheap and durable building materials is a matter of importance to British Honduras, and the Imperial Institute has been able to do some useful experimental work there. Then again, for many years past, we have taken an interest in the use of charcoal for fuel in vehicles adapted to use producer gas instead of petrol, and some British Guiana timbers were very satisfactory.

MISS MARSON: Well, that's good work. Could you now give me in just a few words a picture of the West Indian Court in your Exhibition Galleries?

SIR HARRY LINDSAY: On entering the Court, the first object which strikes the eye is a large, attractively coloured relief map which shows the Bermudas and all the Islands in the Caribbean Sea as well as the neighbouring coastline of the American Continent, with the two Colonies of British Honduras and British Guiana. Next we come to the dioramas, or illuminated picture models which are the work of skilled artists. Each diorama is about 6 ft. by 4 ft., and shows a modelled scene in vivid colours—one to illustrate the Blue Mountain Coffee of Jamaica; another a banana plantation in Jamaica; then the Lime Industry of Dominica; Sea Island Cotton of St. Vincent; a cocoa plantation in Trinidad; sugar-cane in British Guiana; and the Kaieteur Falls.

The remaining three dioramas tell the story of Trinidad Lake Asphalt; first the discovery of the pitch by Sir Walter Raleigh in 1595; then a present-day scene with workers digging the pitch and transporting it to a refinery for treatment; and, finally, a modern motor road in England with workers using Trinidad Lake Asphalt for road surfacing. Thus, a Trinidad

product and Trinidad workers are linked up with workers and industry in the home country, and their mutual inter-dependence is graphically illustrated.

MISS MARSON: I'm always fascinated by those stories of West Indian products. You tell them so interestingly in your show-cases.

SIR HARRY LINDSAY: Yes, the specimens of products are amazingly interesting, for they are arranged so as to tell the life-story of each product—its production, processing and utilisation. All the principal industries of the West Indies are described in this way.

MISS MARSON: Well, that's a tremendous advertisement for us. And now to go on to another important aspect of your work. To what use do you put these Galleries which you are taking so much pains to keep up to date?

SIR HARRY LINDSAY: Yes, Miss Marson, I'd nearly forgotten that. In normal peace-times between one-half and three-quarters of a million of visitors passed through our Galleries every year, and at least 80 per cent. of them were school children. We used to have classes of 25 or 30 children at a time coming to study some particular country, whether Dominion or Colony, and our Guide Lecturers would take them round the Courts and explain different exhibits.

MISS MARSON: Now, Sir Harry, have you told me all the story of this great organisation?

SIR HARRY LINDSAY: As a matter of fact, Miss Marson, there are some other activities which are quite important. Take our films, for example. It isn't usually known that every day the Imperial Institute sends out on an average over 250 films of the Empire, Dominion and Colonial, on loan to schools throughout the United Kingdom. I'm sure you'll agree with me that that is an education in itself, and a most vivid way of getting the story of the Empire across to the rising generation here.

MISS MARSON: Well, it does seem to me that the next generation in Britain will know more about the Empire than the present generation does, and that is all to the good. And you mentioned lecturers just now. Tell me, Sir Harry, how is your Empire lecture scheme getting on? I'm sorry I can no longer lecture for you on the West Indies; it was such fascinating work.

SIR HARRY LINDSAY: Yes, indeed, Miss Marson, and you were a great help to us. I only wish you had been able to carry on. We now have about 90 lecturers on our panel and all of them have lived in the Overseas Empire so that they really do know what they are talking about. Only last month we arranged over 80 lectures on the Overseas Empire to schools throughout the length and breadth of England, and this month the number will be nearly 100.

MISS MARSON: All this in spite of the war! Tell me, Sir Harry, how has the war affected your educational work?

SIR HARRY LINDSAY: Well, unfortunately, we had to close the Galleries as soon as war broke out, but we encourage school parties and other visitors to come to the Galleries by special arrangement. But, of course, there are a great many schools which cannot take advantage of our Galleries or Cinema or Institute lectures—so we do our very best to send these services out to the schools.

MISS MARSON: And, of course, that is where the great importance of your Empire lectures scheme comes in. Really, I am realising more and more how invaluable is the work that you and your staff are carrying on with such energy at the Imperial Institute. On behalf of our listeners in the West Indies, may I express our gratitude and best wishes for the furtherance of the work.

SIR HARRY LINDSAY: Thanks, Miss Marson, it's a great privilege to have been entrusted with this work, and I feel that when the war is over we shall have done something to promote better understanding, good will and good fellowship between all countries of the Empire.

MISS MARSON: I am sure you will, Sir Harry, and thank you very much for coming along to-night to talk to our listeners in the West Indies.

PLANT AND ANIMAL PRODUCTS

ARTICLES

AGAR-AGAR

It was pointed out in the article by Dr. M. Ashby on " War-time Drug Supplies and Empire Production " in this BULLETIN, 1941, **39**, 16, that up to that time there was no commercial production of agar-agar within the Empire and it seemed highly desirable that efforts should be made to find a source of the material to replace the supplies which hitherto had come from Japan. Since then the question has been investigated in several parts of the Empire. A preliminary statement on the work which is being carried out in this country was published in the *Chemist and Druggist* for August 30, 1941, and a paper contributed by the Division of Fisheries on investigations in Australia appeared in the *Journal of the Council for Scientific and Industrial Research*, 1941, **14**, 221. Important work is also being carried out in New Zealand and the Imperial Institute has received for publication the following paper on the results so far obtained. In view of its general interest the Australian paper referred to above is also printed here.

I. AGAR PRODUCTION IN NEW ZEALAND

By L. B. Moore

Botany Division, Plant Research Bureau, Department of Scientific and Industrial Research, New Zealand

New Zealand is credited with some eight species attributed to the *Gelidiaceæ* (Laing's Reference List of New Zealand Marine Algæ), the family to which the best agar yielding seaweeds belong. The most promising of these have been reviewed and three seem to warrant serious consideration for commercial exploitation. After preliminary trials by the present writer had shown that a strong gelling agar could be made from fairly common species a quantity of weed was submitted to a commercial chemist for processing and comment. His product performed as well as controls of Kobe No. 1 Japanese agar in test cans of sheep tongues in a large meat works, in bacteriological cultures in the Wellington Public Hospital, and in standard mycological research. Experiments in large scale production are actively proceeding, but the following summary of results to date may be useful as an indication of the possibilities,

especially in view of reports of recent attempts in Britain to make an agar substitute from the carrageen types of seaweed.

Species Suitable.—Two species of *Pterocladia* (*Pt. lucida* and *Pt. capillacea*) seem to offer the best commercial possibilities because of their relative abundance and easy identification combined with a good agar yield. At least one species of the closely allied genus *Gelidium* is worth considering, but it is smaller to handle and much more readily confused with similar but valueless weeds. Comparative tests of yield and quality have not been made, as any advantage in these is likely to be outweighed by practical considerations of collecting.

Habitats.—*Pterocladia lucida* grows where rocks run into clean deep water. It tolerates strong wave action, but not much sand and is never found within estuaries. On vertical rock faces it grows in a narrow band about low tide level between the small brown weeds above and the long coarse ones below. In a good bed it is heavily matted and almost unmixed with other species.

Pterocladia capillacea is also a plant of the open coast, but it tolerates more sand and grows at a higher level. It is found most abundantly in clean permanent rock pools about half-tide mark.

The *Gelidium* grows on pebbly and shelly bottoms both above and below low tide in rather still estuarine waters. Field studies on these small weeds are still incomplete.

Reproduction and Regeneration.—It is important that regeneration should be sufficiently rapid to ensure continuity of supplies. No definite reproductive season has been determined, but as far as Pterocladias are concerned there would probably always be a sufficient reserve of plants in deep water and on rough coasts to make good any temporary depletion. At Wellington *Pterocladia capillacea* after cutting can regain its full length in eight months, but a bed takes longer to recover completely.

Distribution.—The distribution of most New Zealand seaweeds is known only in very general terms, but the agar weeds are more abundant in the warmer northern waters. Probably in the North Island any rocky coast exposed to the open sea could provide some Pterocladia.

Collection.—Pterocladia may be gathered directly from rocks at low tide in relatively calm weather, or from drift after storms. The second method is preferable in that the natural growing places are not disturbed or artificially depleted, but by the first, from a boat or by wading, large quantities can be collected in a very short time.

Drying.—Pterocladia dries quickly and easily. It is best first rinsed in fresh water and then hung on fences or spread thinly on concrete in the sun. Under these conditions and with fairly frequent turning it can be prepared for packing in one day.

Quantity.—A running survey has been made of the east coast from Whangarei (North Auckland) to Napier (Hawkes Bay) and

considerable beds of both species of Pterocladia have been located. Concentrating on the larger and more easily handled *Pt. lucida*, of which the fronds average about 9 in. in length, instruction was given in selected centres and arrangements made for the Department of Scientific and Industrial Research to buy the clean dry weed through seaside storekeepers who received a small commission. From five centres between March and August (i.e. in four autumn and winter months) a total of 1,270 lb. has been received, of which nearly 1,000 lb. came from a stretch of less than 30 miles of coast in the Bay of Plenty, where the population is rather sparse and predominantly Maori, and the gathering was done mainly by children. This gives some indication of quantities to be expected from organised summer collecting throughout the range of species.

Quality.—The weed sent in has been well selected and free from other species though overgrowing sponges and calcareous seaweeds are sometimes present in small quantities. The drying has been reasonably thorough, and there is no loss through deterioration.

Large Scale Agar Production.—The half-ton of Pterocladia on hand is to be processed by the Dominion Laboratory by standard methods, including freezing. Preliminary difficulties with technique and apparatus are being rapidly overcome and adequate samples should soon be available for despatch to Britain. Calculations are being based on a 30 per cent. yield. The dry weed delivered in Wellington has cost 9*d.* per lb., but no estimate can yet be made of processing costs. If these can be kept down to a reasonable level it seems safe to recommend that local manufacture be undertaken, and to predict that several tons of agar could be turned out per annum without unduly depleting supplies of raw material. Only a small portion of the available coastline has yet been drawn upon, and as collectors become more familiar with the types required it should be possible to make use of the smaller species also. Even if this did not cover New Zealand's normal peace-time needs (about 13 tons per annum, mostly for canning sheep's tongues) it should provide a significant contribution towards Britain's war-time requirements for bacteriological and other essential purposes.

Results may be summarised:

(1) New Zealand has seaweeds that make good agar.
(2) Coast dwelling people are prepared to collect and dry at least the larger species at a reasonable price.
(3) Indications are that with adequate organisation, workable quantities will be forthcoming.

[Whilst this article was in the press the Imperial Institute received from the New Zealand Government Offices in London a copy of a memorandum on agar circulated to members of the Plant Research Bureau Committee of the New Zealand Department of Scientific and Industrial Research, which supplements in some directions the information given above by Miss Moore. With

the kind permission of the New Zealand representatives the greater part of this memorandum is reproduced below.

"The following interim report has been received from Mr. W. A. Joiner, of the Dominions Laboratory, on the commercial scale extraction of agar.

"The process of extracting agar from seaweed is a relatively simple one. After washing, the dried weed is digested with hot water at a temperature of 240° F. (corresponding to 10 lb. per sq. in. (gauge) steam pressure). The volume of water for a given weight of weed is adjusted to give a workable solution of agar of say 1 per cent. to 2 per cent. strength. After digestion the agar solution is run off, filtered and allowed to cool. A strong jelly is formed on cooling and this is cut up and frozen. This causes separation of ice crystals from the agar which is set free on thawing the frozen jelly with cold water. The agar is then dried in a current of warm air.

"The above is merely a bare outline of the process and in practice a number of successive digestions would be carried out in order to extract as much agar as possible from the charge of seaweed. It will be seen, however, that as the concentration of agar must be kept low, large volumes of material have to be handled.

"Following small scale experiments made at this Laboratory arrangements were made with the Gear Meat Co., Ltd., for the use of facilities at Petone for the extraction of sufficient agar to provide samples for submission to users in Great Britain and in this country.

"Some difficulty was experienced in getting the use of suitable plant for the large-scale experiment and it was possible to do only the digestion, filtering and freezing at the Gear Works. The thawing and crushing of the ice and the drying of the agar were done at this Laboratory. 100 lb. of seaweed were extracted and a yield of some 15 lb. of agar obtained. This does not represent the yield commercially possible as with the makeshift facilities available, considerable losses were to be expected, and it was possible to make only one digestion.

"In order to determine the yield to be expected in commercial operation experiments are at present being continued in the light of experience already gained.

"The 15 lb. sample is in powder form and has been packed in tins containing 3 oz. each. The powder is prepared for biological purposes, but it is understood that users in the meat packing industry are accustomed to the leaf form. It would be possible, of course, to prepare leaf agar, but samples of this form could not be produced on this occasion owing to difficulties in providing the large number of jelly trays required and in drying the separated agar."]

II. AGAR-AGAR, A NEW POTENTIAL INDUSTRY IN AUSTRALIA

Contributed by the Division of Fisheries

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In October of last year a sample of a red seaweed, *Gracilaria confervoides*, was sent to the Fisheries Division of the Council for Scientific and Industrial Research by Mr. Laver, of the State Fisheries Department. The seaweed had been discovered in quantity at Bateman's Bay by Colonel Pilmer, who had recognised its qualities. Experiments were thereupon begun by an officer of the Fisheries Division, and a high quality sample of commercial agar-agar was prepared. Subsequent samples have been analysed and show properties on the whole equal to agar previously imported from Japan.

Agar-agar was used in Australia before the war for many purposes, including certain canned meats, confectionery, and other products. It also has uses in the paint and leather industries, but most important from a defence point of view are its uses in the preparation of bacteriological media and in surgical dressings. The consumption of agar for this purpose is of the order of half a ton per annum, and the total consumption in 1938 was 71 tons at a price ranging from 3*s*. to 5*s*. per lb., all imported from Japan.

The Fisheries Division has worked out the details of a process for which a pilot plant is to be erected to clear up a few problems related to the translation of the process from the laboratory scale to the commercial. This plant, with some modification, will be able in emergency to supply Australia's medical needs, if required.

In studying the occurrences of *Gracilaria*, Mr. R. Bouchier, of Cronulla, has rendered valuable services to the Division, and beds of this weed are known to exist in at least four estuaries on the south-east coast of Australia, as well as in the Swan River in Western Australia. Mr. Bouchier's suggestion led to the discovery of a large tonnage of the seaweed washed up on a beach close to Sydney, and it is expected that further deposits of the weed will be washed up in known places during the next few months. Reports from other sources indicate that *Gracilaria* is widespread and that supplies of raw material will be abundant for large scale manufacture.

The seaweed is shaken free from sand, preferably by washing at the water's edge, and is hung on hurdles to dry and bleach with the sun, rain and air. When thoroughly dry it is baled up and sent to the factory. Not more than 5 per cent. sand and 20 per cent. total moisture are allowed for the seaweed to bring top price. The cost of harvesting has yet to be assessed, and will vary with the purity of the deposits of weed.

Baled weed will keep almost indefinitely, but moisture causes mould growth and rotting. The dried *Gracilaria* somewhat resembles hemp in appearance and texture. Its manufacture is relatively simple. It is washed for two to four days in running water to remove the salt, and then placed in wire baskets and boiled with water at 230° F. to 240° F. In this way it is given three successive boilings, the liquor from the last boiling being used for the second, that from the second for the first and so on. The liquor from the first vat is then filtered, or, if a high quality product is required, cleared with charcoal, and then filtered using a filter-aid such as filter-cel or an Australian equivalent. It can be filtered at 212° F. or higher and only sets at about 110° F. After filtration it is allowed to set, care having been taken to keep the concentration of the liquor as high as possible during extraction to produce a firm gel. The gel is then cut into fine strips about ¼ in. in section, laid on trays and frozen overnight. It can then be dried in the sun or in a drying tunnel, and strips similar in appearance to the Japanese strip-agar are produced.

The greater the care used in filtration the less the need for the freezing and thawing of the gel which is a method of purification.

Commercial houses are used to the transparent strips of agar and their reaction to other forms such as powdered agar produced by direct drying from the filter-press liquor remains to be seen.

No complete survey of all possible areas of occurrence of *Gracilaria* has been made or is even contemplated by the Fisheries Division at the present time, owing to pressure of other work, but sufficient locations are known for the Division to feel confident that it is time to recommend the commercial undertaking of an agar industry in Australia, so as to make use of this year's harvest of seaweed. It is believed that such an industry will be able to compete on the overseas market after the war owing to the comparative ease with which this particular species of *Gracilaria* can apparently be harvested.

A great deal of work remains to be done to study the rate and density of growth of the seaweed and to ensure a continuity of supply for the future. A large export trade may be possible, while present knowledge seems to allow of a steady supply to meet all or most of Australia's essential needs.

[Since this paper appeared the Imperial Institute has received a communication from the Chief of the Division of Fisheries, dated September 17, 1941, in which he states that " the results of tests carried out so far show that the agar produced from *Gracilaria* has a higher ash and slightly higher nitrogen content than Japanese agar, and rather lower gelling power ; it grows most bacteria just as well, especially pathogens, including the hæmophils, but gives poorer growths of Rhizobium and allied soil bacteria. This, however, may be due to traces of copper from the apparatus used for preparing

the particular sample. I hope that further work may improve the product, and I believe that we can stimulate commercial enterprises here to begin production some time next year."]

PRODUCTION OF BOTANICALS IN NEW ZEALAND

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For some time before the outbreak of hostilities between Germany and Great Britain in 1939, research into the possibilities of the production of certain crude drug materials in New Zealand was being considered. With the declaration of war a definite programme was formulated and experimental work commenced as it was realised that in the event of Continental supplies being cut off as in 1914-1918 the Empire would require to be self-supporting for supplies of at least a number of important botanicals.

Seed stocks of drug plants which it was considered would do well under New Zealand conditions were imported from various parts of the world. The following species were secured:

Aconitum napellus (Aconite).
Atropa belladonna (Belladonna).
Barosma betulina (Buchu).
Carum carvi (Caraway).
Colchicum autumnale (Colchicum).
Coriandrum sativum (Coriander).
Datura metel
Datura stramonium } (Stramonium).
Digitalis lanata
Digitalis purpurea } (Digitalis).
Ephedra sinica
Ephedra nebrodensis
Ephedra gerardiana
Ephedra intermedia } (Ephedrine).
Foeniculum officinale (Fennel).
Hyoscyamus niger (Hyoscyamus).
Mentha piperita var. *citrata* (Peppermint).
Papaver somniferum var. *saibana* (Opium).
Polygala senega (Senega).
Ricinus communis (Castor Bean).
Valeriana officinalis (Valerian).

An experimental area of 4 acres was chosen close to Wellington. The climate is indicated roughly in the following figures, taken over a period of ten years at a nearby meteorological station.

Annual rainfall	40 in.	
Bright sunshine	2,000-2,100 hours.	
Average wind run per day	190-200 mls.	
Screen temperatures:		
Summer	Mean	60° F.
	Mean max.	66° F.
	Mean min.	54° F.
Winter	Mean	46° F.
	Mean max.	51° F.
	Mean min.	41° F.
Yearly extremes	Max.	75° F.—80° F.
	Min.	32° F.—35° F.
Relative humidity (*per cent.*)	Av. Summer—73	
	Av. Winter—78	

The soil is mainly a silty loam of alluvial origin. In parts a clay wash from nearby hills tends to make it slightly heavier soil.

Small plots were planted in the late spring of 1940 with some of the species noted in the list above, and tests made of the material obtained therefrom. The following are some of the results obtained on analysis by the Dominion Laboratories, Department of Scientific and Industrial Research, Wellington.

Atropa belladonna	Flowering shoots (English seed)	0·88 per cent. total alkaloids.
	Stem leaves at flowering (English seed)	0·38 „ „
**Digitalis purpurea*	Leaves from flowering local plants	14 units per gram.
	Leaves from rosette plants (seed from Paris)	18 „ „
Datura stramonium	Leaves from flowering plants (local and imported)	0·34 per cent. total alkaloids.
Hyoscyamus niger	Leaves from annual plants in flower (Paris seed)	0·05 per cent. total alkaloids.
	Leaves from biennial plants in first year (Astrin Bros., England)	0·13 „ „
Ricinus communis	Beans from plants grown at Auckland (seed from Australia)	56 per cent. oil.
	Beans from plants grown at Wellington (seed from U.S.A.)	45 „ „
Mentha piperita var. *citrata.*	Leaves from non-flowering plants (plants from Australia)	0·32 per cent. oil (not quite up to required standards of purity).
Chenopodium ambrosioides	Flowering and seeding tops (seed from Northern N.Z.)	0·1 per cent. oil.

* *A biological assay carried out by the British Pharmaceutical Society indicated that locally-grown leaf was quite satisfactory. A satisfactory result was also obtained by a biological assay conducted by the Medical School, Otago.*

Many more of the plants listed will be tested during the 1941-42 season. More extensive tests, selections and other investigational work will be carried out.

All the species showed good growth in the preliminary trials and produced viable seed.

Methods of harvesting and drying have yet to be investigated. An experimental drier is being erected and trials will commence shortly.

Commercial production of dried leaf from *Digitalis purpurea* is being undertaken this year. A shipment of leaf from wild plants is to be made during September, October, November and December 1941. This will be followed by a further shipment from cultivated plants during January, February, and March 1942. Trial shipments of the dried leaf of *Atropa belladonna, Hyoscyamus niger* and *Datura stramonium* will also be made to Great Britain during February-March 1942. As seed stocks of other important species are increased and larger areas sown, it is intended to test the market with these.

Preliminary investigations on the medicinal properties of some native plants have been made, and it is intended to develop this work considerably.

It is not the intention of this article to raise any false hopes that New Zealand will soon, or ever, become a large production centre for botanical drugs. Its purpose, rather, is to make known to the industry the experimental work which has been, and is now being done in this country, in an endeavour to produce for use in New Zealand and other Empire countries, botanical drugs which have normally been imported from foreign countries.

NOTES

Obituary.—Sir Arthur Hill. It is with profound regret that we record the death on November 3, 1941, as the result of a riding accident, of Sir Arthur Hill, K.C.M.G., M.A., D.Sc., F.R.S., F.L.S. Sir Arthur had been concerned with the administration of the Royal Botanic Gardens, Kew, for many years, being appointed Assistant Director in 1907 and succeeding Sir David Prain as Director in 1922.

Throughout this long period he had maintained close contact with the Imperial Institute, and in 1926, on the reorganisation of the Institute, he joined the Board of Governors as the representative of Kew and also became a member of the newly formed Advisory Council on Plant and Animal Products. He took a prominent part in the deliberations of these bodies and his valued advice, based on wide experience of the economic products of the Empire, will be greatly missed.

Mr. O. D. Roberts.—The Institute has also suffered a sad loss through the death on November 1, 1941, after a long illness, of Mr. O. D. Roberts, F.I.C., a Senior Assistant in the Plant and Animal Products Department. Mr. Roberts, who was in his 59th

year, received his training as a chemist at the Finsbury Technical College and after a period with a firm of manufacturing chemists, he joined the staff of the Imperial Institute in 1909. He worked for some years in the Mineral Laboratory, and was then transferred to the Plant side, where he specialized on essential oils and fibres. In both these directions he became recognised as an expert and at the time of his death he was Secretary of the Imperial Institute Consultative Committee on Essential Oils and a member of two committees of the Textile Institute (the Advisory Committee on Standardisation in Textiles and the General Technical Committee on Identification of Fibres).

Most of Roberts' work was contained in official reports made by the Institute to overseas Governments, but he found time to prepare a number of papers on essential oils presented to the Chemical Society and the Society of Chemical Industry. These included papers on oils of *Kaempferia ethelae*, *Barosma venusta*, *Cymbopogon senaarensis*, Indian deodar wood, wild pimento leaves, and *Ocimum gratissimum*, the first two being written in collaboration with the late Dr. E. Goulding. His other published work included papers on the gum-oleo-resin of *Boswellia serrata*, the constants of Indian Beeswax (with Mr. H. T. Islip) and the Factors affecting the Composition of Tobacco Ash.

Roberts was a man of quiet, unassuming temperament, conscientious and dependable in his work. He was greatly respected by his fellow workers for his genuineness and his shrewd sense of true values in scientific as in social matters, and he endeared himself to all his friends by his truly gentle nature.

Irrigation in India.—An interesting lecture on the development of irrigation in India was given by Sir Bernard Darley, C.I.E., M.I.C.E., at a meeting of the India and Burma Section of the Royal Society of Arts held in conjunction with the East India Association on November 14, 1941.

The Government, said the lecturer, had spent over £100,000,000 on canals throughout India. These irrigate annually some 30 million acres and the value of the crops raised by the help of this water is estimated at nearly £70 million annually. Government does not seek a great return for the money expended; actually, the canals as a whole pay about 5 per cent. on the capital outlay after meeting expenses.

The important factor is that they have banished famine and brought prosperity and contentment to the cultivator. As the years go on the benefits conferred by these canals will become more and more apparent as they are called upon to help to provide food for the ever-growing population.

It is Sir Bernard Darley's belief that "the blessings of these canals will rank as the greatest achievement of British Rule in India."

The lecturer stated that only a few works of any magnitude were constructed before the country came under British rule. Probably the oldest of these was the Cauvery Delta system of canals which were supplied from an ancient stone weir built some 1,700 years ago.

The first efforts of the British engineers under the East India Company were directed towards the improvement of old indigenous work. The Western and Eastern Jumna Canals were reopened in 1821 and 1830 respectively, and the old masonry weir across the Cauvery in Madras was replaced by a new weir with sluices and the remodelled canals opened in 1838.

The terrible famines which ravaged the country led to the rapid expansion of irrigation works both by the East India Company and, later, by the Government of India. During the Orissa famine of 1856-66 over a million people died, or about a quarter of the population. Starvation was the yearly dread of millions until canal systems and railways were built and serious famine banished from the land. Gradually the waters of every river in Northern India were harnessed and more and more land protected until, by 1920, only a few large schemes about which there had been considerable controversy remained. In Central and Southern India huge storage dams were constructed which held up the monsoon rainfall for use during the dry months of the year.

After the last Great War three huge canal projects were sanctioned. These were the Sukkur Barrage Canals in Sind, the Sutlej Valley Canals in the Punjab and Bahawalpur and Bikaner States and the Sarda Canal in the United Provinces.

The Sarda Canal.—The Sarda Canal takes off from the Sarda river on the borders of Nepal in the north of the United Provinces. It commands some seven million acres in Oudh and Rohilkand. It has 4,177 miles of main canal distributaries and is the longest canal in the world. In addition some 1,500 miles of drainage channels were constructed to carry off rain-water quickly. The cost of this scheme was £7,500,000.

The difficulties encountered when constructing the headworks and upper reaches of this canal were immense. The headworks are situated in the heart of one of the most fever-stricken forests in India, where the average monsoon rainfall is over 100 in. each year. All labour had to be imported.

The first task was to clear some 400 acres of dense forest at the headworks to enable workshops, labour camps and store sheds to be built. It was also necessary to cut a wide belt some 60 miles long through similar forest for the main canal and one of the main branches.

The work was eventually completed in 1928, but not before many of those employed had either died or ruined their health through incessant bouts of malaria.

The Sind and Punjab Canals.—The country to be irrigated (by

the Sind and Punjab canals) was very different to that in the Sarda canal. Apart from riverain tracts already irrigated during the flood season, the country was waterless desert. The rainfall is only 3 to 5 in. a year and spring level is generally a 100 ft. or more below the surface. Before the canals were built this desert was only inhabited by nomad tribes of camel breeders who wandered here and there seeking fodder for their animals amongst the sparse scrub thorn bushes.

Colonisation of the desert areas where land was good offered few difficulties. All unclaimed land was taken over as Crown waste; some was auctioned in large blocks, but for the most part it was sold to peasant proprietors who poured in from the overcrowded districts further north. No peasant proprietor is allowed to purchase more than 50 acres in all, and they are allowed to pay by easy instalments as they earn money from the land.

The area is divided into villages and men of the same community are given land together. Each village is given one or more water-courses and the cultivators generally arrange amongst themselves to divide the water fairly, each man taking all the water in his turn. If necessary, however, a canal officer fixes the turns when the people cannot agree amongst themselves.

Villages are all laid out on a model plan with wide streets and a central square. Large market towns are similarly laid out at intervals and sites sold to enterprising shopkeepers and mill owners. I have seen a town with 5,000 inhabitants spring up in five years with wide paved streets and numerous three-storey shops on either side, selling everything from farm implements to sewing-machines and gramophones. There is also a large cotton mill, an oil mill, and an excellent Government school, a hospital and a veterinary hospital, besides, of course, a police station and revenue buildings.

During the crop season buyers come from far to purchase wheat or cotton, as the case may be, for export by means of the new railway which has been constructed to connect the market towns with the outside world. Thus a thriving and contented community soon comes into being depending for their very lives on the blessing of canal water.

The Sukkur Barrage Canals.—The Lloyd Barrage at Sukkur is the largest work of this kind in the world. It consists of 66 spans of 60 ft. each which can be closed by steel gates and the water headed up and passed into canals. Taking off from either canal are seven canals in all. These have a total length of 6,400 miles and they can draw off a combined discharge of 46,000 cu. ft. per second. These canals command a gross area of 7½ million acres, of which 5⅓ million acres will eventually be irrigated. Some 3¾ million acres were desert land, while the remainder received water in the past during the flood season from old inundation canals. The total cost of this great scheme to date has been over £21 million excluding interest charges.

The Sutlej Valley Scheme.—A scheme of almost greater magnitude though not so spectacular is the Sutlej Valley Project in the Punjab. This scheme was designed to utilise the surplus water in the Beas river below its junction with the Sutlej.

There are in all 10 canals taking off above four barrages (one of which is second only to the Sukkur Barrage in order of magnitude for works of this nature in the world), with a total length of 9,600 miles. These draw a combined discharge of 48,516 cu. ft. per second. It was anticipated that 5 million acres would be irrigated by these canals, of which 2 million acres of desert land would be colonised and brought under cultivation. The total cost of this great scheme has been over £16 million. It is difficult to visualise the magnitude of these three great schemes, but some idea may be gained when it is said that each of them commands an area greater than the whole of the cultivated area in Egypt.

The Mettur Dam.—The fourth great work undertaken during the past 20 years is the Mettur Dam, on the Cauvery River in the Madras Presidency.

The Mettur Dam is by far the most massive dam in the British Empire and second only to one other dam in the world. It comprises more than twice the volume of masonry and concrete contained in the Assuan dam on the Nile. It is nearly a mile long and 214 ft. high. The reservoir above covers an area of 59 sq. miles and contains 93,500 million cu. ft. of water. The water so stored is used to supplement the supplies of the old Cauvery canals and also to irrigate a new area of 301,000 acres. This great scheme has cost some £5 million and is a work of first magnitude.

The Haveli Scheme.—The last big project to be completed in India is the Haveli Canal, taking off the Chenab River in the Punjab. The canals are expected to irrigate 888,000 acres annually, of which 550,000 acres received a precarious supply in the past from old inundation canals.

The Thal Canal.—One large canal remains to be completed in Northern India—the Thal Canal, which it is understood is now under construction. This canal will take off the Indus River and will irrigate a dry sandy tract badly in need of water.

With the completion of this project the waters of all rivers in Northern India will have been utilised as far as it is economically possible to do so and no further major schemes are possible.

Future Development.—It will now be necessary to turn to new methods for any future development.

The first method that suggests itself is the tapping of the vast reservoirs of subsoil water by means of tube wells. A scheme of this nature was first undertaken some years ago near Amritza, in the Punjab, where a large fall on the upper Bari Doab was harnessed and the electrical power developed was run out to various tube wells in the surrounding country. A similar project, but on a much more extensive scale, has been undertaken of late years in the

United Provinces. There a scheme costing over £2½ million is nearing completion. Several falls on the Upper Ganges canal have been harnessed and the electrical power developed is utilised both for light and industrial purposes in 88 towns in the northern portions of the Provinces, and also for pumping water from Government and private tube wells.

Some 1,500 tube wells have been sunk by the Government. Thus nearly 600,000 acres are irrigated annually in areas which cannot be given canal irrigation.

A scheme of some magnitude has also been undertaken in the United Provinces to pump water from the Gogra River which lies too low to permit of flow irrigation in the ordinary manner. No doubt similar schemes will be undertaken elsewhere throughout India.

Another possible form of development is the further construction of storage dams to hold up monsoon rainfall. All the best sites in Central and Southern India have been utilised, but further works of this nature will no doubt be undertaken as the years go on.

It is unfortunate that the rock of which the Himalayas are formed is so fissured that very few sites exist where high storage dams can be built.

One notable work has been projected in the Punjab. There a suitable site exists on the Sutlej River and various schemes have been prepared for a dam, which is known as the Bakra Dam. Proposals for this dam varying from one 400 to one 500 ft. high have been made with reservoirs above holding 80,000 to 120,000 million cu. ft. of water.

Unfortunately the reservoir would submerge a very large area of Bilaspur Independent State, and the Ruler has raised objections which it has not yet been possible to meet satisfactorily. This is sad, because this water would have enabled an area which has constantly suffered from drought and famine to receive the blessing of canal water. No doubt also a share of this water would be given to supplement the supplies of the Sutlej Valley canals which so badly need it in dry years.

Lastly, there is the question of making existing supplies go further. Only about 50 per cent. of the water entering a large canal reaches the fields, the remainder is absorbed into the ground on the way or lost by evaporation. Extensive experiments are being made at present with various materials for lining canals to see if any cheap and efficient method can be devised which will check this leakage.

Linseed Growing, with Special Reference to the Tropics.—In the present exceptional circumstances the possibility of the local production of materials hitherto imported from other countries is being considered in many Colonies. Among these products is linseed, and the following note prepared at the Imperial Institute in response

to a specific inquiry from the West Indies may prove of interest to others in the tropics.

Some authorities regard the range of latitudes within which linseed can be grown as roughly between the 10th and 65th parallels of both north and south latitude. Nearer the equator the plant can only be cultivated successfully at an appreciable altitude. In the Netherlands East Indies, for example, where the plant has been cultivated successfully experimentally it has been found that the iodine value of linseed decreases when the crop is grown at low altitudes, and that in this area a satisfactory drying oil is not obtained when the crop is cultivated below some 3,500 ft. Similarly, in Kenya, where flax fibre has been successfully produced, altitudes of from 7,000 to 9,000 ft. gave the best results. Both these territories are within 10 degrees of the equator.

As a rule different types of flax are cultivated according to whether flax fibre or linseed is to be produced. To obtain the fibre the crop is harvested (preferably " pulled ") before the seed is fully mature, but some yield of seed is obtained which may be employed for linseed oil extraction. The fibre crop is also sown at a closer spacing to discourage branching, whereas in linseed production a wider spacing is adopted as branching is desired. In recent years dual purpose varieties have been evolved. These have been developed for cultivation in temperate regions and so far as the Imperial Institute is aware they have not been tried out in the warmer lands.

Linseed may be successfully grown on a fairly wide range of soil types. In India, for example, the plant does equally well on both the heavy deep moisture retaining soils of Central and Peninsular India and on the lighter Gangetic alluvium of the United Provinces and Bihar. However, different types of linseed are required for these different soil conditions, in the former circumstances the varieties cultivated are deep-rooted producing large seed, whereas in the latter soils slow-growing shallow rooted varieties produce a smaller seed but a greater total yield.

In India linseed is extensively cultivated in several provinces, but does not seem to be widely grown south of about latitude 16° N. In the important producing areas the average rainfall varies from about 30 to 70 in. per annum. Linseed is a Rabi or cold weather crop, and in some provinces much of the acreage is grown mixed with such crops as wheat or gram, in others it is largely cultivated as a sole crop. In Bengal, for instance, a fairly heavy soil is preferred, and adequate cultivation to conserve moisture is advised. In this area the crop is sown in October, or early November, and is harvested in February or March. The seed rate recommended is 16 to 24 lb. per acre and the yield under favourable conditions may be from 650 to 730 lb. per acre. With specially selected seed a return of 820 to 975 lb. per acre is said to be obtainable.

In general any average medium soil should be suitable, though

to some extent soil requirements will vary with the climate as a lighter soil may give the best results where the rainfall is heavy. The soil should not be too light, however, as the crop suffers from drought, thus a subsoil which retains moisture is desirable, and as linseed is susceptible to weeds the land should be clean. The aim should be to provide a fine surface to the seedbed with firm soil beneath. It is difficult to broadcast linseed evenly by hand as the seed is slippery. The seed-rate per acre will depend on the method of sowing, but a satisfactory stand should be obtained with about 30 lb. per acre; hand broadcasting usually requires more seed than other sowing methods. Linseed probably succeeds best following a crop that has been well manured, but if the soil is poor a complete dressing of artificial manures may be employed. Heavy nitrogenous manuring is not required.

Linseed is harvested when the earliest bolls are ripe and the crop is left to mature in the field in stooks. It should be stacked or threshed as soon as it is thoroughly dried or loss from shedding may occur. The yield depends on a number of factors, and on the country of production, and although much higher returns have been obtained a yield of from about 500 to 700 lb. per acre might not be exceeded.

Cottonised Fibres.—Considerable attention has been paid in recent years to the question of producing from bast fibres such as flax, hemp, Asclepias, etc., a staple fibre of suitable length and fineness for spinning on cotton machinery. Numerous processes to this end have been patented and in essentials these consist of breaking down the strands into their ultimate fibres by the action of alkali. The idea of preparing a staple fibre in this way, however, is an old one. At the Great Exhibition of 1851 a Mr. P. Claussen, of the United Kingdom, was awarded a prize medal for a series of specimens in illustration of his patent process for making flax cotton. His process is described in the Reports of the Juries of the Exhibition in the following terms:

"This process (patented August 1850) consists essentially in boiling the cut and crushed stems of the flax, hemp, or other plant, in a dilute solution of caustic soda, containing about one two-thousandth part of alkali. The fibrous matter is then removed and plunged into a bath of dilute sulphuric acid, containing one five-hundredth part of acid, in which it is boiled for about an hour. It is next transferred into a solution containing about ten per cent. of carbonate of soda; and lastly, when it has remained in the latter for an hour, it is plunged into a weak solution of sulphuric acid, consisting of one part of acid to two hundred or five hundred parts of water; in this it is left for about half an hour, and the process is completed. The effect of these several processes is 'to divide and split up' the fibre in a most remarkable manner, so as completely to alter its character. Flax thus treated is converted

into a substance very nearly resembling cotton. It is probable that flax cotton can be advantageously used in the manufacture of mixed fabrics, as it appears capable of being spun with wool, silk, and other fibres. It may, therefore, perhaps hereafter lead to several new and important practical applications."

Many earlier attempts on the same lines were made, and the following account taken from the same publication will no doubt be of interest to many to-day:

"In 1747 Lilljikreuzes and Palmquist described a mode of converting flax into 'cotton' by boiling it for some time in a solution of caustic potash, and subsequently washing it with soap. In 1775 considerable quantities of refuse flax and hemp were converted into 'flax-cotton' by Lady Moira, with the aid of T. B. Bailey, of Hope, near Manchester. The full details of the process employed do not appear to have been published; but from Lady Moira's letters in the 'Transactions of the Society of Arts for 1775' it appears that the fibre was boiled in an alkaline lye, or a solution of kelp containing carbonate of soda, and subsequently scoured. The result of this was, that 'the fibres seem to be set at liberty from each other,' after which it may be 'carded on cotton cards.' It appears that at this time 'flax cotton' was made and sold at threepence a pound; and Lady Moira states that she believes that it takes colours better than flax. It is curious to observe the fate of Lady Moira's scheme: she says, 'I have no reason to be vain of the samples I have sent you, they merely show that the material of flax cotton, in able hands, will bear manufacturing, though it is my ill fortune to have it discredited by the artisans who work for me. I had in Dublin, with great difficulty, a gown wove for myself, and three waistcoats; but had not the person who employed a weaver for me particularly wished to oblige me, I could not have got it accomplished; and the getting spun of an ounce of this cotton in Dublin I found impracticable; and the absurd alarm that it might injure the trade of foreign cotton had gained ground, and the spinners, for what reason I cannot comprehend, declared themselves such bitter enemies to my scheme, that they would not spin for me. Such is my fate, that what between party in the metropolis and indolence in this place (Ballynahynch), I am not capable of doing my scheme justice. That it should ever injure the trade of foreign cotton is impossible. Though long accustomed to behold shoes and stockings looked upon in this part of the world by the generality as quite unnecessary, yet I cannot think but some apparel is requisite; and as the price of wool is so high, and the poverty of the people so great, I did wish to introduce amongst them that invention which I saw might be greatly improved, and turn the refuse of flax into comfortable clothing, and by a process so easy that every industrious wife and child might prepare it.' Lady Moire states that the flax-cotton gowns which she had had made, and which were worn by the members of her own family, were

exceedingly durable; and the specimens of these fabrics, as well as of the flax-cotton prepared by her, which are still preserved in the Museum of the Society of Arts, etc., are highly remarkable for their beauty.

"Subsequently to this several attempts were made in Germany to convert flax into a fibre resembling cotton, which could be used, either alone or together with cotton, in the manufacture of cotton goods. In 1777 Baron Meidinger proposed to convert flax into a sort of cotton, by the action of alkaline solutions, etc. In 1780 a factory was established at Berchtoldsdorf, near Vienna, for the practical working of this process; and similar plans were subsequently brought forward by Kreutzer in 1801, Stadler and Haupfner in 1811, by Sokou in 1816, and by several others. At the factory at Berchtoldsdorf not only was flax converted into cotton, but likewise a useful cotton-like fibre was prepared from tow and refuse flax; and the same is said to have been done by Haag, near Pressburg, in 1788, by Göbell in 1803, and Segalla in 1811. Whether these various plans failed from the effects of jealousy and opposition, like that which prevented Lady Moira from introducing her 'flax-cotton,' is unknown, but it does not appear that any of them were long persevered in; it is probable that in most cases the neighbouring manufacturers set themselves against the introduction of flax-cotton; for Beckmann, who speaks of its manufacture near Brunswick, states that the work-people determined not to use the new material, though, at the same time he observes, that excellent fustians were made which could not be distinguished from those manufactured with ordinary cotton. The extreme similarity of flax-cotton to ordinary cotton is also remarked by Des Charmes (1799), who states that if the staple is cut before it is carded it is not possible to distinguish it from cotton either in its raw state or when manufactured. The matter was subsequently investigated by Berthollet, by Gas Lussac, and by Giobert, who employed alternately steepings in hot solutions of soap, alkali, and sulphuric or muriatic acid. Berthollet observes that equally fine cotton is obtained from the commonest refuse tow as from the best flax."

The Conservation of Activity in Papain.—The precise nature of the enzymic activities of papain has been the subject of considerable uncertainty and disagreement. The differences in the properties of freshly tapped latex obtained from fruits at different stages of development, variations in activity of preparations made by different methods from the latex, deterioration in activity on keeping, the action of "activators," notably hydrogen cyanide, in increasing or restoring activity, and the presence of natural activators and inhibitors in the latex, have all been the subjects of contributions to technical journals.

Reference may be made in particular to a communication made to *Nature* (1937, **139**, 249) by M. Frankel, R. Maimin and B. Shapiro,

of the Hebrew University, Jerusalem, and to various papers by A. K. Balls, of the United States Department of Agriculture and his collaborators (*J. Biol. Chem.*, 1937, **121,** 737; *ibid.*, 1939, **130,** 669; *Ind. Eng. Chem.*, 1940, **32,** 1144; *ibid.*, 1940, **32,** 1277.)

Pending clarification of these various problems a practical interest attaches to United States Patent No. 2,257,218, September 30, 1941, granted to A. K. Balls, H. Lineweaver, and S. Schwimmer, assignors to the Secretary of Agriculture of the United States, entitled "Process for the Preparation of Papain." It is claimed by the patentees that whereas papain as ordinarily prepared by drying the latex of the green fruit is less potent per unit of dry weight than the latex from which it is prepared, and deteriorates on storage even for periods as short as a few weeks, the new process results in a product which retains nearly all the original activity of the latex and may be stored for many months without apparent deterioration. It is stated that the natural activator of the proteolytic enzymes, which occurs in the latex in considerable quantity, remains in the finished papain.

The process consists simply in adding common salt to the latex, either before or after it has clotted, mixing thoroughly, and then partially drying the mixture, preferably in a vacuum and at a temperature not exceeding 55° C. The quantity of salt used may vary within wide limits, but with latex of average water content may be about one-tenth of the weight of the fresh latex. The evaporated product, consisting of a greyish white thick paste, should be kept in airtight containers.

Utilisation of Sawdust.—The following summary of the various ways in which sawdust can be used is reproduced from the *Monthly News Letter No.* 113 of June 1, 1941, issued by the Division of Forest Products, Council of Scientific and Industrial Research, Australia.

The problem of economic disposal of sawdust is a difficult one, despite its many and varied uses, of which the chief is fuel. Some uses make no special demands, but for specialty purposes sawdust to be satisfactory must conform with certain requirements of colour, particle size, moisture, resin or tannin content. For some of these special purposes sometimes trade custom is so firmly established that it is very difficult to arrange even a trial of sawdust from species other than those already approved.

The main uses of crude sawdust are:

(1) Fuel (green or dry).
(2) Litter—bedding down of cattle, protecting dance floors, covering domestic floors during redecoration of walls and ceilings, butchers' floors, and for sweeping compounds to prevent dust from rising.
(3) Packing—for goods in transit.
(4) Insulation.
(5) Stuffing—for cushions, dolls, toys, etc.

(6) Food Preservation.
(7) As an Ingredient in Compositions.
(8) For Wood Meal and Wood Flour for use in explosives, linoleum and plastics.
(9) Abrasive or Absorbent—for rumbling, polishing, drying and cleaning.

(1) *Fuel*

The use of sawdust for fuel offers the greatest possibilities for absorbing large quantities of green or dry sawdust, but this is fundamentally dependent on local markets, as transport costs make its use uneconomic at even short distances from its source. For industrial heating the ideal method is to burn it as fuel for boilers fitted with a step grate furnace or a Dutch oven. For domestic purposes it is again necessary to use special burning equipment. Although such sawdust burning stoves and hot water heaters already in common use in Europe, Canada and United States of America are reported as being wonderfully successful the use of sawdust for this purpose has only recently been introduced into Australia.

An alternative to the burning of sawdust in loose form is to manufacture briquettes which can be burnt in ordinary fire places, stoves, or furnaces. To do this successfully it is essential to have either a cheap binding material—which is at present unobtainable in Australia—to enable briquetting at low pressures, or to have expensive and elaborate machinery capable of briquetting without the addition of a binder by employing very high pressures. For the latter operations to be worth while it is essential to have a large output—at least 9 tons per day—to operate the smallest economic plant, and this costs in U.S.A. approximately 15,000 dollars.

There are definite limitations to the amounts that can be absorbed for Items 2-9, and it is only plants favourably situated in or near centres of large population that have the chance to contact potential users who will pay satisfactory prices for all but very special types of sawdust. Consequently it is always desirable to make a survey of the potential local markets.

(2) *Litter, etc.*

Dry sawdust is necessary for bedding cattle, protecting dance floors and domestic floors, but apart from this no other particular restriction on sawdust seems necessary for purposes such as the above.

(3) *Packing*

Sawdust for packing should be dry, free from injurious chemicals and for many purposes should be odourless. As a substitute for granulated cork for packing grapes it should be fairly coarse but free from splinters. Suitable sawdust can be cut with a special drum saw or may be obtained by sieving.

(4) *Insulation*

Sawdust for packing ice-chests, refrigerators, cool stores, etc., should be dry, free of strong odours or volatiles which will contaminate goods placed therein.

(5) *Stuffing*

For stuffing cushions, doll's bodies, etc., sawdust should be dry and free from splinters or too much fine dust.

(6) *Food Preservation*

Sawdust is a regular fuel for producing smoke to smoke fish or cure meat. For this purpose it may be wet. It must give off a satisfactory volume of smoke of such a quality that it will not impart any undesirable odour or flavour to the foods.

(7) *As an Ingredient in Compositions*

(*a*) *Floors.*—Sawdust is an important ingredient in quite a number of flooring compounds. The mineral base of most of these substances is magnesium oxychloride. Probably the most common filler is wood, chiefly in the form of sawdust. There is considerable variation in the type, kind, grade, and proportion of sawdust used in making composite flooring. Chiefly, however, hardwood of 20 to 40 mesh is used. The proportions of sawdust in the mixture may vary from 4 per cent. to 70 per cent. and more. One type of flooring, in which 70 per cent. sawdust is reported as used, employs kiln-dried hardwood sawdust of 20 mesh for the top layers and coarse softwood sawdust for the base. Another type of composition flooring is said to contain 85 per cent. sawdust.

Sawdust is often used in composition floors that are to be covered and to which it is desired to nail the covering. The sawdust makes the floor light and porous so that the nails can be readily driven into it.

(*b*) *Concrete Products.*—Sawdusts and shavings are used to some extent as fillers in various types of concrete-like products. Concrete of these types is light and porous, holds nails and screws well, and has fair insulating qualities. One concern uses mineralised sawdust (sawdust treated with iron compounds) in making a light weight concrete. About one-third to one-half of the weight of the material is sawdust. The product is said to be highly wear resistant, fire resistant, a non-conductor of sound, and more comfortable to walk on than concrete. It can be sawn, nailed, screwed, and polished. Sawdust-concrete floors are sometimes laid where it is desired to attach wooden construction by means of screws and nails.

The use of sawdust in place of sand in the making of cement barn floors has also been found, in at least one instance, to produce a floor which is warmer and less wearing on the hoofs of the cattle than ordinary cement, and the report states that after

several years the floor was still in as good shape as when first laid. Reports of other similar concrete work, however, are not so satisfactory.

(*c*) *Cast Products.*—The number of products made by casting mixtures containing sawdust is increasing. Burial vaults are made of sawdust concrete. Tile, fire brick, shingles, and plumbing ware have also been cast. One firm making the items noted uses 80 to 90 per cent. sawdust in the mixture. The cast products are said to hold nails well, can be sawn, are waterproof, and fireproof up to 2,600° F. Other cast articles are refrigerators and floor marble. A very beautifully mottled wall and floor tile has a high percentage of shavings in its composition. It is very successfully used for bathroom and other interior purposes.

(*d*) *Stuccos and Plasters.*—There are several composition stuccos and plasters on the market that use sawdust as fillers. The wood particles help to bind the mass together. The resulting mixtures are lighter and more porous than ordinary stuccos and plasters. They can be nailed without damage, and are said to have better insulating qualities than the ordinary product.

One of these compounds, said to contain 85 per cent. sawdust, is used for stuccoing, interior plastering, and by modifying the mixture, for floors. Another is sold as wood plaster. The filler of this compound is ground sawdust.

The use of sawdust plasters and stuccos is not increasing greatly, and the chances of any considerable development along these lines are not very promising.

(*e*) *Gypsum Compositions.*—Sawdust is used in the manufacture of a number of commodities of gypsum. Sawdust decreases the weight of the products, makes them more porous, increases their insulating qualities, softens the material so that it can be nailed and sawn, and lessens the cost of the finished articles. The following are typical gypsum products in the manufacture of which some sawdust may be used: interior partitions, floor insulation, wall insulation, wall boards, cast products of a variety of kinds, and roofing material. The last-named product is a recent addition to the family of gypsum-sawdust products.

Sawdust and shavings used in mixtures with gypsum are usually light coloured, light weight and of non-staining species.

(*f*) *Clay Products.*—In the manufacture of porous clay bricks and tile it is necessary to mix with the clay a substance which will be consumed during the burning and leave the finished product filled with fine cavities or pores. For this purpose either sawdust or finely chopped straw is used. The sawdust should be dry and sifted to produce uniform results.

Hollow clay tile for partitions is made light and porous by adding 25 to 35 per cent. sawdust. In the burning process the sawdust burns out, and the resulting product is soft and porous. When certain clays are used the product can be nailed and cut with

ease. A semi-porous tile is made by adding 20 per cent. sawdust. The use of sawdust in the manufacture of clay and gypsum products is probably decreasing, because of the rather general use of " bubbling " compounds for the purpose of expanding the mass to lighten its weight and increase porosity.

(g) *Artificial Wood.*—Composition boards said to have the properties of wood and reputed to act in use like ordinary timber have been made, but so far as we know they are not marketed commercially.

The following formula patented in France for a typical mixture of this kind is : Sawdust, 33 per cent. ; paper waste, 20 per cent. ; casein glue, 22 per cent. ; limestone or chalk, 10 per cent. ; water, 15 per cent. The proportions are varied somewhat with the type of product. The ingredients are ground together to make a uniform mixture, then moulded and dried. The board can be reinforced by placing pieces of wood in the mould.

(8) *Wood Meal and Wood Flour*

(a) *For Explosives.*—Wood meal is used as an absorbent and a source of carbon in some explosives. A certain limited percentage of resin, volume/weight ratio, nitro-glycerine absorption, prescribed particle size and low moisture content appear to be the fundamentals. Whereas in the past explosives manufacturers were particular to specify—prepared from white pine sawdust or other similar softwood —it has recently been demonstrated that provided the wood meal conforms with the fundamentals numerous species or blends of species yield satisfactory wood meal for explosives.

(b) *For Linoleum and Plastics.*—Wood flour for these purposes is usually prepared from non-resinous coniferous timbers although some of the medium and low density pored timbers are used satisfactorily. It must be dry, have the requisite particle size and texture and the necessary volume/weight ratio. For many purposes it must be almost white and have a low resin content.

New types of plastic, in which 80 to 85 per cent. by weight of the materials used is sawdust are being developed. Ordinary dry sawdust, which in tests so far has been hardwood, is hydrolysed after which it is dried and ground to the fineness of wood flour. To this dried mass certain chemicals are added and the whole thoroughly mixed. The resulting stock is placed in heated moulds, and under heavy pressure produces a very satisfactory plastic. Sawdust plastics have great possibilities in that they possess many desirable properties and can be produced at low cost.

(c) *Moulding Compounds.*—Sawdust ground to the proper fineness is used as an ingredient in many moulding compounds used for the manufacture of such articles as dolls heads. Common binders are starch, flour, animal glue, resin, gutta-percha, gum arabic, rubber latex, casein and blood.

(d) *Plastic Wood.*—Plastic wood for stopping holes or repairing

cracks, etc., is made from wood flour, nitro-cellulose, ester gum and other materials dissolved in solvents.

(9) *Absorbent or Abrasive*

Sawdust is frequently used as an absorbent for cleaning water or other liquids from small metal articles. It is also used as an abrasive and buffer in rumblers for polishing small metal goods.

For both these purposes it must be dry, and in special cases must be free from resins and tannins.

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Annual Report on the Forest Administration of Nigeria for 1940. Pp. 14, 10 × 6¾. (Lagos: Government Printer, 1941.) Price 1*s.*

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The Internal Application of Chemicals to Kill Elm Trees and Prevent Bark-Beetle Attack. By R. R. Whitten. *Circ. No.* 605, *U.S. Dep. Agric.* Pp. 12, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1941.) Price 5 cents. An account of experimental work, employing chiefly copper sulphate and sodium arsenite.

The Economic Importance of Malayan Ambrosia Beetles. By F. G. Browne. *Malay. For.*, 1941, **10,** 59-64.

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An Examination of Some Australian Hardwood Charcoals with Special Reference to their Suitability for Charcoal Gas Producers. Part II. By E. C. Plante. *J. Coun. Sci. Industr. Res. Aust.*, 1941, **14,** 191-200.

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British Standard Grading Rules for Structural Timber. The 800 lb. f. Grade Redwood, Scots Pine, European Larch and Douglas Fir (Home-grown). *Brit. Stand. No.* 940-1941. Pp. 12, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: British Standards Institution, 1941.) Price 2*s*.

Tests on Small Clear Specimens of Merawan jangkang (*Hopea nervosa* King) in a Green Condition made at the Timber Research Laboratory, Sental. *Malay. For.*, 1941, **10**, 106-110.

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Preparation and Analysis of Run Manila Copal. By C. L. Intengan and A. P. West. *Philipp. J. Sci.*, 1941, **75**, 83-93.

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The Story of Wattle (or Mimosa). The World's Modern Tanning Material. By S. G. Shuttleworth. *Sci. Bull. No.* 168, *Dep. Agric. Un. S. Afr.* Pp. 28, $9\frac{3}{4} \times 7\frac{1}{4}$. (Pretoria: Government Printer, 1941.) Price 3*d*.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 16

(July to September, 1941.)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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The Work of the Division of Insecticide Investigations, 1927-1939. By R. C. Roark. *U.S. Dept. Agric., Bur. Entomol. Plant Quarantine*, E.516, 1940.

Science Wars on Insect Pests. By R. A. Deno. *J. Amer. Pharm. Assoc., Practical Pharm. Ed.*, 1941, **11**, No. 5, 202-205. Includes general account of contact insecticides.

Insecticides and Exterminators. By J. M. Vallance. *Mfg. Chem.*, 1941, **12**, No. 8, 178-182. General account, includes vegetable insecticides.

" Poison " or " Insecticide " in Economic Entomology. By S. Marcovitch. *J. Econ. Ent.*, 1941, **34**, No. 4, 583-584.

Report on Insecticides, Fungicides and Caustic Poisons. Pyrethrum, Derris and Cube. By J. J. T. Graham. *J. Assoc. Off. Agric. Chemists*, 1941, **24**, No. 3, 651.

Derris, Cube and Pyrethrum under Export Control. *Oil, Paint, Drug Rep.*, 1941, **140**, No. 2, 5, 49, 50. Brief note on imports and sources of supply.

Insecticidal Smokes: their Application in the Control of Household Insects. By L. D. Goodhue and W. N. Sullivan. *Soap*, 1941, **17**, No. 8, 98-100.

Dust as an Inhibiting Factor in the Reproduction of Insects. By S. E. Flanders. *J. Econ. Ent.*, 1941, **34**, No. 3, 470.

Insecticidal Dusts. A Study of the Effect on Mortality of Electrostatic Charges produced by Friction in applying Insecticides. By H. F. Wilson, C. E. Dieter and H. L. Durdick. *Soap*, 1941, **17**, No. 4, 99, 101, 121. Different diluents for insecticidal dusts tested.

Measuring Average Particle Diameter of Powders. An Air-Permeation Apparatus. By E. L. Gooden and C. M. Smith. *Industr. Engng. Chem., Anal. Ed.*, 1940, **12**, 479-482. (*R.A.E.*, 1941, **29**, A, Pt. 8, 397.)

Insecticide Protection. *Soap*, 1941, **17**, No. 4, 113. Brief note of U.S. Patent (No. 2,168,064) by which derris, pyrethrum and cube insecticide materials are coated with light-reflecting pigments (e.g. titanium oxide) to inhibit loss of toxicity on exposure to light.

Field Trials with two new Contact Insecticides. By W. R. Roth and L. Pyenson. *J. Econ. Ent.*, 1941, **34**, No. 3, 474. Mannitan monolaurate with rotenone and pyrethrins tested.

Cattle Spray Testing. By F. G. Nelson. *Soap*, 1941, **17**, No. 8, 92, 93, 97.

Plant Sprays. A Report on the Feasibility of the Use of Household Insecticides for Plant Spray Purposes. By T. L. Carpenter. *Soap*, 1941, **17**, No. 8, 102-104, and No. 9, 105, 107, 109.

Insect and Other Pests of Corn. By Q. F. Otanes and L. T. Karganilla. *Philipp. J. Agric.*, 1940, **11**, No. 4, 403-428. Derris and nicotine sulphate recommended for the control of certain pests.

Cabbage Caterpillars. *Ministr. Agric., Lond., Adv. Leafl.* 69 (1941). Dusting with derris recommended for control; also spraying with derris or pyrethrum.

Control of Codling Moth with Arsenate of Lead and certain forms of Rotenone and Pyrethrum. By B. G. Pratt. *J. Econ. Ent.*, 1941, **34**, No. 3, 424.

Flea Beetles. *Minist. Agric., Lond., Adv. Leafl.* 109 (Amended 1939). Derris and nicotine dusts recommended for control.

Control of the Flea Beetle. *Phyllotreta vittata discedens* Weise in the Texas Gulf Coast. By M. J. Janes. *J. Econ. Ent.*, 1941, **34**, No. 4, 518-519. Effective control with cube-sulphur dusts; pyrethrum-sulphur dusts less effective.

Contact Insecticides for Chinch-bug Control. By E. V. Walter and C. Benton. *U.S. Dep. Agric., Bur. Entomol. Plant Quarantine*, E.530, March 1941. (*Amer. Chem. Abstr.*, 1941, **35**, No. 14, 4903.) Tests with nicotine, derris and pyrethrum mixtures.

Control of the Pink Bollworm with Insecticides. By A. J. Chapman and W. L. Lowry. *J. Econ. Ent.*, 1941, **34**, No. 4, 490-492. Fixed nicotines showed some promise; derris dust proved disappointing.

Laboratory Experiments on Poison Baits for the Brown and Red Locust (S. Afr.), 1937-38. By A. Lea and M. C. A. Nolte. *Dep. Agric., Sci. Bull. No.* 230 (*Locust Research Series No.* 9), 1941. Derris, cube, nicotine tannate tested in addition to organic and inorganic compounds.

Pea Aphid Control in Maryland during 1940. By L. P. Ditman, C. Graham and E. N. Cory. *J. Econ. Ent.*, 1941, **34**, No. 4, 560-562. Derris dusts and sprays gave better control than cube, dusts being the most effective, especially when very finely ground. Nicotine sprays highly effective when properly applied.

Toxicities of Bordeaux Mixture, Pyrethrum and Derris to Potato Leafhoppers. By T. C. Watkins. *J. Econ. Ent.*, 1941, **34**, No. 4, 562-565. Only pyrethrum suspension showed any appreciable toxicity in the test method used.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Tobaccos for Nicotine Extraction. By M. Benincassa. *Boll. Tec. 1st Sper. Colt. Tabacchi "Leonardo Angeloni" Scafati*, 1940, **37**, 81-87 (*Amer. Chem. Abstr.*, 1940, **35**, No. 15, 1941). *Nicotiana rustica* var. *tombak* cultivated in Italy reported to contain 7·58–8·17 per cent. nicotine (on dry base). The species gives a lower yield of dry matter than *N. tabaccum* but has a higher content of nicotine.

Determination of Nicotine and Anabasine when present in a Mixture. By M. F. Khmura. *Vsesoyuz. Nauch. Issledovatel. Inst. Tabach. i Makhoroch Prom. No.* 140 (1939), 97-102 (*Amer. Chem. Abstr.*, 1940, **34**, 4862).

The Establishment of a Home-made Cuprous Oxide Mixture as a Citrus Fungicide in Southern Queensland. By F. W. Blackford. *Queensld. Agric. J.*, 1941, **61**, Pt. 1, 24. Discusses nicotine sulphate treatment of aphis attack in relation to question of compatability of fungicidal and insecticidal treatments.

The Control of Cabbage Root Fly. By D. W. Wright. Further Experiments on the Control of the Cabbage Root Fly (*Delia* (*Hylemyia*) *brassicæ* Bouche). By D. W. Wright. *J. Minist. Agric., Lond.*, 1940, **46**, No. 8, 765-772, and 1940, **47**, No. 3, 187-191. (*R.A.E.*, 1941, **29**, A, Pt. 8, 384-385.) Recommends dipping roots in nicotine solution before planting out.

Effect of Boll Weevil Control and Cotton Aphid Control on Yield as shown in a Factorial Experiment. By R. C. Gaines. *J. Econ. Ent.*, 1941, **34**, No. 4, 501-504. Nicotine dust used for control of cotton aphid.

Other Alkaloid-containing Materials

Ninth Report (from April 1, 1936, to March 31, 1938) of the Department of Science, Ministry of Economic Affairs, Bangkok, Thailand (1940), p. 30. Use of the root of *Stemona* sp. ("Ka Piad" or "Non Thai Yak") as an insecticide in pepper plantations. An alkaloid was isolated from the root.

Determination of Nicotine and Anabasine when present in a Mixture. By M. F. Khmura. *Vsesoyuz. Nauch.-Issledovatel. Inst. Tabach. i Makhoroch Prom. No.* 140 (1939), 97-102 (*Amer. Chem. Abstr.*, 1940, **34**, 4862).

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Les légumineuses insecticides. By M. Tilemans. *Bull. Agric. Congo Belge*, 1941, **32**, No. 1, 126-193. General account of rotenone-producing plants.

Derris et Lonchocarpus, insecticides végétaux. By F. Fallon. *Bull. Agric. Congo Belge*, 1941, **32**, No. 1, 112-125. Suggested cultivation in Belgian Congo.

Annual Return of Statistics relating to Forest Administration in British India for the year 1938-39 (1941), pp. 12-13. Brief reference to work on native species of derris (*D. ferruginea* and *D. cuneifolia*) and allied plants (*Millettia pachycarpa* and *Tephrosia candida*).

Toxicity of Rotenone. By R. C. Roark. *Soap*, 1941, **17**, No. 9, 93.

De absorptie-spectra van derride, isorotenone, malaccol, toxicarol en sumatrol. By T. M. Meyer. *De Ingenieur Ned.-Indie*, 1941, No. 3.

Depression of the Melting Point of *a*-Toxicarol and Related Compounds in Soft-glass Capillary Tubes. By H. A. Jones and J. W. Wood. *J. Amer. Chem. Soc.*, 1941, **63**, 1760.

Rotenone-containing Plants. Occupational Dermatosis. By J. Racouchot. *Arch. Maladies Profess.*, 1939, **2**, 149-151. (Abstract in *J. Amer. Pharm. Assoc. Sci. Ed.*, 1941, **30**, No. 7, 207.)

Insecticidal Properties of the Fatty Acids. By E. G. Thomssen and M. H. Doner. *Soap*, 1941, **17**, No. 4, 94-98. Includes discussion of possible part played by fatty acids in vegetable oils used as activators for rotenone.

Report of the Chief of the Bureau of Animal Industry, 1939-40, U.S. Dep. Agric., 1940. (*R. A.E.*, 1941, **28**, B, Pt. 7, 119.) Derris and cube found equally effective in washes for the control of warble fly in cattle.

A Preliminary Report of the Control of Comstock's Mealybug on Apple. By J. A. Cox. *Va. Hort. Soc. Rep.*, 1940, **45**, 84-88. (Abstract in *Exp. Sta. Rec.*, 1941, **84**, No. 6, 791.) Summer oil sprays showed promising results when combined with rotenone.

Derris

Leaf Spot of Derris. By P. R. Santos. *Philipp. Agric.*, 1941, **29**, No. 8, pp. 641-659. General account of the disease, which affects *D. elliptica* and *D. philippinensis* and measures recommended to reduce infection.

Derris elliptica—Guatemala. *Industr. Ref. Service, U.S. Dep. Comm.*, Pt. 1, No. 11. Note of successful experimental plantings in Guatemala. Planting material may be distributed by the Ministry of Agriculture.

Derris Root in Japan. *Chem. Tr. J.*, 1941, **109**, August 1, 52. Note on the establishment of an industry in Taiwan.

Malayan Agricultural Trade in 1940. By D. H. Grist. *Malay. Agric. J.*, 1941, **29**, No. 6, 235. Includes brief note on derris market and exports.

The Export Crops of the Netherlands East Indies in 1939—Derris. *Malay. Agric. J.*, 1941, **29**, No. 4, 167. (From Annual Report No. 4 of the Central Bureau of Statistics of the N.E.I.) Note giving area under derris and figures for production and export.

Ninth Report (from April 1, 1936, to March 31, 1938) of the Department of Science, Ministry of Economic Affairs, Bangkok, Thailand (1940), p. 47. Experiments with derris extract from locally-grown plants.

Use of Derris in the War on Lice. *Malay. Agric. J.*, 1941, **29**, No. 4, 170. Review of possible needs.

Recent Work on the Sheep Tick, and its Bearing on Control Measures. By J. MacLeod. *Ann. Appl. Biol.*, 1941, **28**, No. 3, 296-297. Use of derris for control.

Concentrations of Derris Sprays effective on the Imported Cabbage Worm. By L. Pyenson and W. R. Roth. *J. Econ. Ent.*, 1941, **34**, No. 3, 473.

Rate of Application of Derris-Talc Dusts for Pickleworm Control. By F. S. Arant. *J. Econ. Ent.*, 1941, **34**, No. 4, 520-521.

Derris and the Control of the Mexican Bean Beetle. By H. C. Huckett. *J. Econ. Ent.*, 1941, **34**, No. 4, 566-571.

Two Buprestid Cane-Borers of Brambles with Experiments on Control. By F. G. Mundinger. *J. Econ. Ent.*, 1941, **34**, No. 4, 532-537. Derris spray found to give satisfactory control.

Control of the Cotton Aphid and the Boll Weevil in 1940. By R. L. McGarr. *J. Econ. Ent.*, 1941, **34**, No. 4, 580-582. The addition of derris to calcium arsenate mixtures used against boll weevil gave effective control of cotton aphid. The addition of nicotine and tobacco dust were not effective.

Black Scale Control. Summary of Studies with low Dosages of Oil with Rotenone-bearing Materials. By A. M. Boyce, J. F. Kagy, G. L. McCall and J. P. LaDue. *Calif. Citrogr.*, 1940, **25**, No. 10, 314, 342-344. (*R. A.E.*, 1941, **29**, A, Pt. 7, 349.)

Control of Pineapple Caterpillar. By C. A. Thorold and A. Pickles. *Trop. Agric., Trin.*, 1940, **17**, No. 11, 215-216. (*R. A.E.*, 1941, **29**, A, Pt. 7, 373.) Fairly heavy applications of derris dust at fortnightly intervals needed for satisfactory control.

The Locust Leaf Miner as a Pest of Soybean. By F. W. Poos. *J. Econ. Ent.*, 1940, **33**, No. 5, 742-745. (*R. A.E.*, 1941, **29**, A, Pt. 7, 354). Heavy application of derris dust gave good results.

Lonchocarpus

Estudio histológico de las partes herbáceas de las especies de *Lonchocarpus* de la Argentina. By C. C. Molle. *An. Prim. Reun. Sul-Amer. Bot. Rio de Janeiro*, 1938, **3**, 241-263. (Abstract in *Trop. Woods*, 1941, No. 66, 41.) Describes anatomy of young stem and leaf of three species and one variety of *Lonchocarpus.*

Prova facil para verificacao da atividade dos timbós. (An easy test for ascertaining the toxicity of timbo.) By J. R. Meyer. *Biologico, Sao Paulo*, 1940, **6**, No. 11, 319-321. (*R.A.E.*, 1941, **29**, B, Pt. 8, 121.) A simple method of evaluation based on the time taken by water extracts to kill fish.

Tratamento de algumas ectoparasitoses pelo timbó. (The Treatment of some infestations of ectoparasites by means of timbo.) By J. R. Meyer. *Biologico, Sao Paulo*, 1940, **6**, No. 12, 352-355. (*R.A.E.*, 1941, **29**, B, Pt. 8, 121.) Dilute water extract of the roots with soap solution used as a dip against fleas and lice on domestic animals.

Others

Annual Return of Statistics relating to Forest Administration in British India for the year 1938-39 (1941), pp. 12-13. Brief reference to work on *Millettia pachycarpa* and *Tephrosia candida.*

Value of Rotenone Roots. *Soap*, 1940, **17**, No. 9, 109. Note on paper by L. D. Goodhue and W. N. Sullivan on chemistry—toxic action of *Tephrosia virginiana* roots, published in *J. Econ. Ent.*, 1941, **34**, 77-78.

PYRETHRIN-CONTAINING MATERIALS

Annual Report of the Department of Agriculture, Tanganyika, for 1940 (1941), p. 4. Brief note on exports and expansion of pyrethrum crop.

Pyrethrum Seed, Rhodesia. *Rhod. Agric. J.*, 1941, **38**, No. 8, 413. Note that some seed is available from plants proved suitable for cultivation in Rhodesia at altitudes above 5,000 ft. on irrigated land.

Annual Report of the Department of Agriculture, New Guinea, for the year ending June 30, 1940. *New Guinea Agric. Gaz.*, 1941, **7**, No. 2, 109. Note on progress of pyrethrum cultivation.

Chilean Drugs and Oils—Pyrethrum. *Chem. and Drugg.*, 1941, **135**, August 9, 76. (From *Foreign Commerce Weekly.*) Note on extent of annual production and exportable surplus of the domestic crop raised from imported Dalmatian seeds.

Memoria de la Estacion Experimental Agricola de la Sociedad Nacional Agraria, Lima, Peru, 1938, No. 11a (1939). (Report of the Agricultural Experiment Station of the National Society of Agriculture, Lima, Peru). (*Pl. Breeding Abstr.*, 1941, **11**, No. 3, 175.) Pyrethrin contents of up to 0·96 per cent. are reported from locally grown flowers.

Pyrethrum—Domestic Crop Possibilities (U.S.A.). *Oil, Paint, Drug Rep.*, 1941, **139**, No. 13, 54. Part of an address by P. Kolachov to the Seventh Annual Chemurgic Conference, Chicago, March 1941. Gives general account of cultivation and production.

Kenya Pyrethrum. How and Why Kenya Flowers have completely displaced Japanese Pyrethrum. *Soap*, 1941, **17**, No. 9, 91-93.

Pyrethrum. *Oil, Paint, Drug Rep.*, 1941, **140**, No. 3, 53. Brief note on U.S. market; basis of selling Kenya and Japanese flowers.

Chemistry and Preparation of Insect Sprays containing Pyrethrum. By A. F. Caldwell. *J. Malaya Branch Brit. Med. Assoc.*, 1938, **1**, No. 4, 336-341. (*Amer. Chem. Abstr.*, 1940, **34**, No. 5, 1438.)

Pyrethrin I Extraction. By J. S. Yip. *Ind. Engng. Chem., Anal. Ed.*, 1941, **13**, 107-108. (Note in *Soap*, 1941, **17**, No. 4, 113.)

The Evaluation of Pyrethrum Flowers (*Chrysanthemum cinerariifolium*). The Extraction of the Flowers for Analysis and the Preparation of Colourless

Concentrates of the Pyrethrins. By J. T. Martin. *J. Agric. Sci.*, 1941, **31,** Pt. 2, 178-185.

Report on Insecticides, Fungicides and Caustic Poisons, Pyrethrum, Derris and Cube. By J. J. T. Graham. *J. Assoc. Off. Agric. Chemists,* 1941, **24,** No. 3, 651. Mercury reduction method adopted as official for Pyrethrin I. A modified Seil test gave more concordant results than the Seil method for Pyrethrin II.

Tests on Crawling Insects. Evaluating Liquid Household Insecticides against the German Cockroach and Bedbug. A Final Report on Research Project at Ohio State University. By F. L. Campbell, C. S. Barnhart and J. M. Hutzel. *Soap,* 1941, **17,** No. 7, 105-107, 109, 111, 113, 115, and No. 8, 104, 107, 109, 111, 113, 115, 121. Detailed account of technique is given for testing pyrethrum sprays.

Pyrethrum Ointment. A Report on its Use in the Control of Lice and Scabies. By W. K. Angevine. *Soap,* 1941, **17,** No. 8, 117, 119, 121.

Household Insect Pests and their Control. By Mohan Singh. *Indian Fmg.*, 1941, **2,** No. 5, 238-241. Reference to pyrethrum powder with sodium fluoride for control of cockroaches.

New Repellent for Biting Insects. *Canada Lumberman,* 1941, **61,** No. 16, 28. Includes concentrated extract of pyrethrum in mineral oil.

The Horn Fly and its Control. By W. G. Bruce. *U.S. Dep. Agric. Leafl. No.* 205, 1940. (*R.A.E.*, 1941, **28,** B, Pt. 7, 107.) Refers to the use of pyrethrum sprays for destroying the flies on the cattle.

Chloropids Swarming in Houses. By C. W. Sabrosky. *J. Econ. Ent.*, 1940, **33,** No. 6, 946-947. (*R.A.E.*, 1941, **29,** B, Pt. 8, 134.) Easily destroyed by pyrethrum dusts and sprays.

Toxicities of Bordeaux Mixture, Pyrethrum and Derris to Potato Leafhoppers. By T. C. Watkins. *J. Econ. Ent.*, 1941, **34,** No. 4, 562-565. Only pyrethrum suspension showed any appreciable toxicity in the test method used.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Il *Solanum nigrum* come insetticida per uso agricolo. (Black nightshade as an agricultural insecticide.) By G. Pollacci and M. Gallotti. *Boll. Soc. Ital. Biol. Sper.* (Naples), 1940, **15,** No. 2, 328-330. (*R.A.E.*, 1941, **29,** A, Pt. 7, 332.)

Acetate of Sabadilla and Spirit of Quassia—Comparative Parasiticidal Actions. By O. Larrson. *Farm. Revy.*, 1940, **39,** 552. (Abstract in *J. Amer. Pharm. Assoc., Sci. Ed.*, 1941, **30,** No. 7, 220.) Possible use of quassia against head lice.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE USEFUL AND ORNAMENTAL PLANTS IN TRINIDAD AND TOBAGO. By R. O. Williams, A.H.R.H.S., and R. O. Williams, Junr. Revised Third Edition. Pp. 265, 10 × 6½. (Trinidad and Tobago: The Government Printer, 1941.) Price $1.00.

This authoritative work was first published in 1927 as a memoir of the Department of Agriculture, Trinidad, by W. G. Freeman, then Director of Agriculture, and R. O. Williams, now Deputy

Director of Agriculture and senior author of the present volume. The original work, which was reviewed in this BULLETIN, 1928, **26**, 258, was followed a year later by a second and revised edition. Thus the appearance of a new edition after the elapse of some thirteen years since the previous revision is very welcome.

In the latest edition the work has been expanded by the inclusion of one hundred and forty new plant descriptions, while many of the notes, particularly those relating to the crop plants, have been revised and brought up to date. The value of this particular revision has been enhanced by the co-operation in their respective spheres of other local botanical and horticultural authorities, whose assistance in different directions is acknowledged in the preface. A useful feature, included for the first time in this edition, is the descriptive keys of ornamental plants which should enable the general reader to identify any new plant that he may come across. The keys are based on very simple and obvious characters and purely technical terms are avoided. This matter combined with the re-arranged lists of useful plants forms a new section occupying some forty pages at the beginning of the volume. In the lists of useful plants brief notes are given, where the utilisation is not obvious, of the part of the plant that is employed and of the use to which it is put. The pages of cultural notes which conclude the latest edition are also new and are designed especially to assist the local gardener in food production.

The major portion of the work, extending to rather more than 200 pages, is provided by the plant descriptions. These as in the previous editions appear in alphabetical order under the botanical names, with cross references under the popular names. They are given in simple language, a form in which the information will be appreciated by the general reader. The value of a work such as this, which can perhaps only be fully appreciated by those who have occasion to use it regularly, is very real, and the present joint authors are to be congratulated on having provided this enlarged and revised edition of a useful standard reference book. It deals with many introduced plants as well as native species, so that it will be of value to all interested in tropical plants.

INDEX TO HORTICULTURAL ABSTRACTS, Volumes I—X, 1931-1940. Compiled by D. Akenhead, Deputy Director, Imperial Bureau of Horticulture and Plantation Crops. Pp. 160, $9\frac{3}{4} \times 7\frac{1}{4}$. (Imperial Bureau of Horticulture and Plantation Crops, East Malling Research Station, Nr. Maidstone, Kent, England, 1941.) Price 25*s*.

The output of technical and scientific literature is now so vast and published in so many languages that the worker in any branch would find it impossible to keep abreast of recent developments if it were not for the many excellent abstract journals that are now

available to him. Not least in merit among these are the periodicals issued by the various Imperial Bureaux in this country. To consult these effectively, however, a really good index is essential. After a lapse of years, however, to consult the separate annual indexes becomes a somewhat laborious task, and the Imperial Bureau of Horticulture and Plantation Crops has performed a most useful service in issuing this Decennial Index to *Horticultural Abstracts.* In it the subject matter of more than 9,500 papers is carefully cross-referenced and there is a separate author index, as well as an errata slip covering the ten volumes.

The ground covered in *Horticultural Abstracts* goes far beyond the commercially cultivated fruits and vegetables and includes almost all cultivated crops, of the tropics as well of temperate regions, other than herbage crops and cereals. The worker in any of the branches covered will therefore find this collected index a guide to most of the important research work published during the last ten years.

A HANDBOOK OF HOME-GROWN TIMBERS. (War Emergency edition.) Pp. iv + 68, $9\frac{1}{2} \times 6$. Department of Scientific and Industrial Research, Forest Products Research. (London: His Majesty's Stationery Office, 1941.) Price 1s. 6*d.*

The fact that in less than two years a new edition of this *Handbook* has been called for is sufficient evidence that it has met a real need. The scope of the work was described in a review of the previous (Second) edition in this BULLETIN 1940, 38, 216. Although war conditions have necessitated a reduction in the number of pages, room has been found for descriptions of many more timbers. Among the new woods dealt with are apple, box, holly, field maple, Norway maple, pear, robinia, mountain ash, whitebeam, wild service.

As the Director of Forest Products Research says in his Prefatory note, since the outbreak of war interest in home-grown timbers has greatly increased, and species which in ordinary times were almost entirely neglected, mainly because supplies were limited and widely scattered, are now in demand to replace foreign timbers for special purposes. With these additional woods included in it, the new edition of the *Handbook* will prove of even greater service to all landowners and others interested in home-grown timbers than previously.

MINERAL RESOURCES

ARTICLES

GORCEIXITE IN SOUTHERN RHODESIA

By A. M. Macgregor, M.A., F.G.S.,
Geologist, Southern Rhodesia Geological Survey

The recent discoveries of a rare mineral in the Gold Coast and Sierra Leone by Dr. N. R. Junner, and in British Guiana by Mr. S. Bracewell, subsequently shown to be gorceixite by the Imperial Institute,[1] have led to a re-examination of a very similar mineral substance found by the writer in 1919 in the Triassic gravels of Somabula.

Gorceixite was originally described by E. Hussak in 1906 from Minas Geraes, Brazil, where as in the four subsequent discoveries the mineral occurs as rolled pebbles in diamond-bearing gravels. The following description was published of the Somabula material:[2]

> " '*Beans.*' A very interesting constituent of the concentrates is a hydrous phosphate of aluminium and cerium. It forms well-polished flattened pebbles, brown, yellow, white or grey in colour, which bear some resemblance to beans. A partial analysis made by Mr. Ernest Edwards at the Mines Office, Salisbury, on a very small quantity of material by fusion in an iron crucible gave the following composition:
>
> $$SiO_2 = 3{\cdot}42,\ Al_2O_3 = 53{\cdot}46,\ Ce_2O_3 = 9,\ P_2O_5 = 19{\cdot}50.$$
>
> Iron and H_2O were not determined. The alkali earths and magnesium were absent. The physical characters: hardness 6, specific gravity $3{\cdot}1 - 3{\cdot}2$, refractive index $1{\cdot}63$, porcellanous fracture and granular structure with extremely minute inclusions, resemble those of certain cerium-aluminium phosphates from the diamond-bearing gravels of Brazil described under the names of gorceixite (georceixite) and ferrazite; these minerals, however, contain barium as an essential constituent, and less alumina. They are locally known in Brazil as 'Favas' or beans."

The composition given above is not that of gorceixite, but the late Ernest Edwards was professionally not an analytical chemist,

[1] *Ann. Rept. Gold Coast Geol. Surv.* 1937-38, p. 6; 1939-40, pp. 15-17. *Bull. Imp. Inst.* 1940, **38**, 475-6; 1941, **39**, 160-164.

[2] Geology of the Diamond-bearing Gravels of the Somabula Forest, by A. M. Macgregor; *Southern Rhodesia Geological Survey Bulletin No.* 8, 1921.

but a mining engineer, who for many years was chief assayer to the British South Africa Company. He had about half a gramme of the mineral to analyse, and was therefore working under considerable difficulties. It is not known what method of analysis he used, but it seems probable that he overlooked the presence of barium and weighed some barium oxide with the alumina. If this assumption is correct and the 14·62 per cent. unaccounted for was water, the analysis can be made to fit fairly closely with the composition of gorceixite, as may be seen in column B of the following table of analyses :

ANALYSES OF RHODESIAN GORCEIXITE

	A	B	Molecular Proportions.	C	Molecular Proportions.
SiO_2	3·42	3·42		1·25	
Al_2O_3	53·46	40·00	·3914 = 2 × ·1957	37·96	·3714 = 2 × ·1857
Fe_2O_3	—	—		3·76	·0235
MgO	—	—		1·28	·0317
BaO	—	13·46	·0878	11·88	·0775
Ce_2O_3	9·00	—	} = ·1426	—	} = ·1498
CeO_2	—	9·44	·0548	7·00	·0406
P_2O_5	19·50	19·50	·1372	22·39	·1575
H_2O	—	14·18	·7878 = 5 × ·1575	15·05	·8384 = 5 × ·1630 + ·0234 in limonite
	85·38	100·00		100·57	

Column A : *Edwards' analysis as originally given.*
Column B : *Edwards' analysis as interpreted.*
Column C : *Golding's analysis.*

A new analysis made by Mr. E. Golding in the laboratory of the Geological Survey, Salisbury, from a single pebble weighing 0·8 gramme is given in column C. The specimen was smoothly polished and had a mottled reddish-brown colour. The specific gravity was 3·185. Under the microscope the powdered mineral is seen to consist of a yellow transparent base crowded with minute dusty inclusions, which make optical examination very difficult. The refractive index was determined as about 1·62. Small chips and edges are anisotropic. Barium and magnesia are present, but no lime. The cerium oxide separated freely with the characters described by Washington,[1] and there seems no reason to question the relatively high proportion of this oxide found. It is, however, a noteworthy feature when compared with other analyses, as is also the absence of lime. These do not affect the general agreement with Hussack's formula of $BaO{\cdot}2Al_2O_3{\cdot}P_2O_5{\cdot}5H_2O$ with partial replacement of BaO by other bases. The differences may have a local significance.

[1] "The Chemical Analysis of Rocks," by H. S. Washington, Third Edition, 1919, pp. 230-31.

Other specimens in the Geological Survey collection, weighing about 3 grammes, have a considerable range in colour. Four range from dark reddish-brown to grey; three are streaky in dark cream and café-au-lait colours.

The Somabula gravels have not been worked during the last twelve years, and there is little information about the ground to add to what has already been published. But recent work in the Mafungabusi hills 100 miles to the north-west enables the beds to be put in their stratigraphical position within the Rhodesian Stormberg series.[1] In the Somabula Forest the diamond-bearing wash rests upon the granite beneath beds of two kinds: (1) very fine sandstone or mudstone with plant fossils, and (2) coarse arkose with pebble beds. The junction between these beds is sometimes vertical owing to a period of erosion when gullies were scoured in the mudstone before the deposition of the arkose. In the Mafungabusi hills each of these groups is over 200 ft. thick, but there is the same evidence of scouring and vertical contacts between the two groups. The Forest Sandstone capped by basalt overlies the arkose, and overlaps it to the south on to granite, in which kimberlite pipes and sills are intrusive. This part of the country was therefore being eroded at the time the Somabula gravels were being formed, and is therefore a more likely source of diamonds, and by inference perhaps of gorceixite, than was previously supposed.

On the other hand the derivation of the metamorphic minerals which are by far the most abundant constituents of the wash (staurolite, kyanite, almandine, chrysoberyl, etc.) from the highly metamorphic zone of the middle Zambesi 200 miles and more to the north becomes more certain as a result of an examination of the common purple garnets of the Miami mica field. These are identical in colour and specific gravity with the commonest garnets at Somabula and have the composition by analysis: almandine, 67 per cent.; spessartite, 26 per cent.; pyrope, 7 per cent.

The amorphous character and unimpressive appearance of gorceixite probably account for a wider distribution of the mineral not having been recognized. One may anticipate its discovery in the Belgian Congo and French Congo, where the diamonds appear to have local sources in Triassic sediments. On the other hand, if the mineral were common in the Union and South West Africa it would surely have been discovered by one of the many able mineralogists who have studied the rich alluvial diamond fields in that part of the continent.

[1] "Geology of the Mafungabusi Gold Belt," by A. M. Macgregor; *Southern Rhodesia Geological Survey Short Report No.* 35, 1941, pp. 7-8.

CANADIAN BENTONITIC CLAYS AS BONDING MATERIALS FOR SYNTHETIC MOULDING SAND MIXTURES

By C. H. FREEMAN

Mining Engineer, Department of Mines and Resources, Ottawa

A report on the testing of five samples of bentonitic clays as bonding material for synthetic moulding sand mixtures, carried out early in 1941 in the Milling Laboratory, Division of Industrial Minerals, Mines and Geology Branch, Department of Mines and Resources, Canada[1]

FIVE samples of bentonitic clays were submitted by Pembina Mountain Clays, Limited, for testing as bonding material for synthetic moulding sand mixtures. Three of these clays designated A, B, and E, were said to be products of the above company from a deposit in Manitoba in section 30, township 3, range VI, west of the first meridian. The E clay, known as their yellow band, is a bentonite. The B clay, known as their black band, is a plastic type. The A clay is a mixture of E and B, but no statement was submitted giving the proportions. The remaining clays, C and D, were of the bentonitic type, the C clay stated to be a domestic one from Alberta, whereas the D clay was the well-known American " Volclay " from Wyoming.

It was desired that the relative values of the various clays as bonding ingredients for synthetic moulding sand mixtures be determined. In order to make up these mixtures, two grades of foundry sand used by the Vulcan Iron Works Ltd., Winnipeg, were provided. Both of these sands were of the rounded grain type, slightly coated with yellow clay and iron oxide. Rounded grains tend to provide maximum permeability but minimum strength. The one designated " coarse," a very coarse-grained type, having a grain fineness number of 47·4, would be suitable for heavy or large castings. The other designated " fine," a medium size grain type, having a grain fineness number of 75·9, would be suitable for castings other than heavy and light weight or thin section castings.

With one exception all the tests made were those adopted as either standard or tentative standard by the American Foundrymen's Association, as presented in their publication, " Testing and Grading Foundry Sands and Clays." The tests pertain to permeability, compressive strength and exact moisture content of all the synthetic moulding sand mixtures made from various combinations of the five clays as bonding material with the two sands as base material at different moisture contents. In all, over sixty tempered mixtures

[1] Published by kind permission of the Canadian Government Trade Commissioner in London.

were tested. The remaining test, which is the exception mentioned above, was that of determining the pyrometric cone equivalents of the five clays so as to secure an indication of the relative values of their refractoriness or durability which might be expected in foundry practice.

Before any moulding sand mixtures were made, the base sands and the clays were given the following treatment. The sands were dried and then screened through a 12-mesh screen so as to break up any lumps. The clays were dried in shallow pans at a temperature of 220° to 230° F. until all free moisture was removed. Owing to the high hygroscopic property of these clays they were stored in air-tight containers to prevent subsequent pick-up of moisture from the atmosphere.

Preliminary small-scale tests were made on a few sand and clay mixtures to determine the amount of clay bonding material to be used in making up batches for the regular tests. From the results of these tests, using the fine-grade sand as a base, mixtures of two clay percentages (4 and 3½) were made from each of the five clays. Four moisture content combinations were made of the 4 per cent. clay mixtures and two moisture content combinations from the 3½ per cent. clay mixtures. Later, from data obtained using the fine-grade sand as a base, it was not found necessary to make as many clay mixtures and moisture content combinations when tests were to be made with the coarse-grade sand. For this sand only one clay mixture, namely 7 per cent., was used for all the clays. Three moisture content combinations were made with each of these clay mixtures. This high clay percentage of 7 per cent. was chosen because rounded grain textured sands provide little compressive strength as compared with angular grain sands. Also coarse-grained sands used for heavy weight castings require more bond than fine-grained sands suitable for lighter weight castings.

The moulding sand mixtures were made in a laboratory size mixer of the muller type. In all charges the combined weights of the sand and the clay were the same, namely 2 kgm. (4·4 lb.). Each charge was mulled dry for two minutes so that the ingredients would be thoroughly mixed. The tempering water necessary to give the desired moisture content percentage plus the estimated amount for loss from evaporation was then added and mulled an additional three minutes. The mulled charge was immediately placed in an air-tight sealer to prevent further loss from evaporation. All such mixtures were allowed to stand for at least one day so that the tempering moisture would become evenly disseminated.

It is to be noted that, when the moulding sand mixtures were made, all quantities were measured by weight and not by volume. Measuring quantities of pulverized clay by volume is certain to be quite erroneous owing to the widely divergent densities of various clays. For instance, of the five clays being tested, the C clay had the lowest density. Assuming the density of the C clay to have

an arbitrary value of 1·0 as a standard, the approximate densities of the other four clays would be as follows: A, 2·0; B, 1·9; E, 2·1, and D, 2·6.

Before any testing was done with the tempered moulding sand mixtures, each was riddled through an eight-mesh screen and promptly returned to its closed container. This was done to obtain as homogeneous a tempered mixture as possible.

All the permeability and compressive strength determinations were the average of at least three tests. No test was included for these determinations if there was a deviation of more than 10 per cent. from the average of the three.

The exact moisture content of each tempered moulding sand mixture was determined by drying at least 100 gm. at a temperature of from 220° to 230° F. and weighing when cool to obtain the loss.

The permeability and compressive strength determinations of the various moulding sand mixtures at the different moisture contents are presented below in the following tables. The underlined moisture content percentages suggest the approximate optimum moistures. This is an indication of the proper amount of tempering water necessary to give best working conditions in moulding practice.

PERMEABILITY AND COMPRESSIVE STRENGTH DETERMINATIONS USING THE "FINE"-GRADE SAND

	4·00 per cent. Clay Mixtures.			3·25 per cent. Clay Mixtures.		
Clay.	Moisture content (tempering) percentage.	Permea-bility.	Compressive strength lb./sq. in.	Moisture content (tempering) percentage.	Permea-bility.	Compressive strength lb./sq. in.
A Pembina	3·3	67·4	9·1	3·4	69·6	5·5
	2·8	76·0	7·8			
	<u>2·3</u>	93·5	9·4	<u>2·3</u>	82·8	7·8
	2·0	72·9	10·1			
B Pembina	3·4	72·4	7·1	3·4	67·7	4·6
	2·8	76·0	7·1			
	<u>2·3</u>	84·3	8·5	<u>2·4</u>	79·2	6·0
	2·0	76·0	7·9			
E Pembina	3·3	74·5	9·8	3·4	70·2	6·3
	2·8	68·7	8·8			
	<u>2·3</u>	99·3	11·3	<u>2·3</u>	83·6	8·5
	2·0	74·2	11·0			
C Alberta	3·4	71·1	8·0	3·4	68·7	5·8
	2·8	91·1	8·2			
	<u>2·4</u>	95·3	9·7	<u>2·4</u>	92·7	7·4
	2·0	85·1	9·5			
D "Volclay"	3·3	68·4	6·5	3·4	70·2	4·8
	2·8	83·4	6·1			
	2·4	83·5	8·0	<u>2·3</u>	80·5	6·3
	<u>2·0</u>	88·4	9·4			

PERMEABILITY AND COMPRESSIVE STRENGTH DETERMINATIONS USING THE "COARSE"-GRADE SAND

7 per cent. Clay Mixtures

Clay.	Moisture content (tempering) percentage.	Permeability.	Compressive strength lb./sq. in.
A Pembina	4·0	210	12·2
	3·7	197	14·5
	3·0	278	15·1
B Pembina	4·1	210	11·7
	3·7	220	12·1
	3·0	237	13·7
E Pembina	4·1	271	12·5
	3·7	315	14·7
	3·0	280	16·6
C Alberta	4·2	256	11·5
	3·7	296	12·3
	3·0	279	14·1
D "Volclay"	4·1	223	11·4
	3·7	271	11·5
	3·0	237	13·9

The refractoriness or durability of any moulding sand depends on various factors. The weakest link in the composition is the clay substance. In order to obtain an indication of the relative refractory characteristics of the clays, pyrometric cone equivalents were made of each of them. These were determined by Mr. G. A. Kirkendale, Ceramic Engineer of this Division, and are as presented below:

Clay.	Pyrometric Cone Equivalent (P. C. E.)	Approximate Corresponding Fahrenheit temperature.
A, Pembina	7	2210°
B, Pembina	3	2093°
E, Pembina	13½	2498°
C, Alberta	13½	2498°
D, "Volclay"	11	2345°

It must be realised that the above P. C. E. and temperatures represent the softening points of the clays and should not be regarded as the temperatures to which these clays may be subjected, with safety, when in use. They are referred to here only as a guide to classifying the clays in comparison with one another as regards probable reaction to high temperatures.

Summary

From a study of the above tables the following deductions are made.

All the true bentonitic clays, E, C, and D, would provide excellent bond for synthetic moulding sand mixtures. The domestic clays E and C are superior to the imported clay D in all respects for permeability, compressive strength and refractoriness. As for the domestic clays E and C, they are quite similar in their bonding qualities, but the preference is given to the E Pembina clay. Out of thirty-six determinations for permeability and compressive strength, only three determinations for permeability slightly favoured the C Alberta clay. For durability they should be equal.

The A clay, said to be a mixture of E and B, is inferior to that of E and superior to that of B. It would serve as a good bond and possibly would be acceptable in some foundries owing to lower price. Moulding sand mixtures made with it would become lifeless earlier than with clays E, C, or D.

The B clay is inferior to any of the other clays, but still is quite plastic enough to provide fair bond. While the life of the clay is retained, good permeability and compressive strength would be available, but owing to its low refractoriness, extra clay bond would soon have to be added or the spent moulding sand discarded. Adding extra clay has the disadvantage of decreasing permeability.

It is to be noted that, had base sands of different textures been supplied for these tests, the determinations for permeability and compressive strength would not have been the same, but the same general trend of results obtained, would be as enumerated in this summary.

ABSTRACTS AND NOTES

Obituary—Charles W. Mathews.—It is with the deepest regret that we have to record the death on September 30, 1941, of Charles W. Mathews, F.G.S., at the age of 68.

Mr. Mathews was one of the most prominent and highly respected figures in the precious stone trade in this country, his business having been established in Hatton Garden for forty-seven years. He was also a famous lapidary and maintained a cutting shop in which many of the finest coloured precious stones cut in this country were produced under his personal supervision.

Always an indefatigable worker in the interests of the gem-cutting industry, Mr. Mathews was the promoter of the scheme to train disabled ex-service men as lapidaries after the last war, which led to the formation of the British Gem Cutting Company and the setting up of training shops. He took a prominent part in the International Jewellers' Congress of 1930 when a valiant attempt was made to reduce the chaotic nomenclature of gemstones in use in the jewellery trade to some sort of order, and up to his death he was a prominent and active member of the Committee of the Pearl, Diamond and Precious Stone Section of the London Chamber of Commerce.

His position as an authority on the valuation of precious stones other than diamonds and as an expert on their cutting, polishing and mounting was widely, even internationally, recognised, and the Imperial Institute was fortunate to number him among the members of its panels of honorary expert advisers on special matters connected with the legal, technical, trade and administrative aspects of the mineral industry. In this connection we recall with sincere appreciation that he was one of the oldest members of our advisory committees, having been a member of the Precious Stones Sub-Committee of the former Imperial Mineral Resources Bureau from the date of its foundation in 1920 until its incorporation with the Mineral Resources Department of the Imperial Institute in 1925, when he became and remained until his death a member of the Consultative Committee on Miscellaneous Minerals.

The precious stones trade is a branch of the mineral industry in which, perhaps more than any other, valuable advice can only be given by a few men who have spent a lifetime in the pursuit of special knowledge and experience. Whenever such advice was required Mr. Mathews was at all times willing to place his unrivalled knowledge and valuable time freely and fully at our disposal. His generosity in this respect and the direct practical value of his advice were very much appreciated and his genial personality will be greatly missed.

South African Mineral Production.—The statistics of mineral production published in the latest *Quarterly Information Circular*, issued by the Department of Mines, Pretoria, which covers the period January to June 1941, show several remarkable changes in comparison with the corresponding period of last year and are reproduced below. They relate to minerals other than gold, silver, and diamonds and other gemstones.

PRODUCTION

Minerals.	January-June 1940. Tons (2,000 lb.).	January-June 1941. Tons (2,000 lb.).
Andalusite	446·00	2,542·00
Antimony	—	366·00
Asbestos		
Chrysotile	208·65	697·48
Cape Blue	3,095·45	3,172·29
Transvaal Blue	1,729·95	503·27
Amosite	8,368·16	9,210·22
Anthophyllite	63·69	33·00
Barytes	344·00	644·00
Chrome	91,258·00	72,406·00
Coal	9,076,101·00	10,621,630·00
Copper—		
Ingot	5,437·25	4,920·00
Gold Concentrates	2,010·65	2,194·90
Blister	—	6,457·35
Corundum	2,039·10	2,940·83
Fluorspar	4,052·00	2,024·00
Graphite	43·52	40·28
Iron Ore	299,519·00	471,444·00
Iron Pyrites	20,788·00	17,767·00
Kaolin	1,317·00	2,256·00
Kieselguhr	60·00	282·00
Lead	109·00	216·00
Magnesite	5,161·00	7,804·00
Manganese	212,713·00	245,919·00
Mercury	—	5,034 *lb.*
Mica—		
Waste	721·00	593·00
Sheet	0·22	0·23
Mineral Pigments—		
Ochres	3,667·00	2,297·00
Oxides	235·00	653·00
Platinum—		
Metallics	38,273 *oz.*	25,258 *oz.*
Matte*	536·24	656·00
Soda Ash	1,285·00	1,375·00
Talc	818·00	973·00
Tin—		
Concentrates	367·65	329·97
Metallic	—	83·46
Tungsten	46·43	47·69
Total	9,742,000	11,481,820

* *Contains approximately 43 oz./ton platinum group metals and gold and 25 per cent. Cu and 40 per cent. Ni.*

PRINCIPAL EXPORTS

Minerals.	January-June 1940.		January-June 1941.	
	Tons (2,000 *lb.*).	F.O.B. Value £	Tons (2,000 *lb.*).	F.O.B. Value £
Asbestos—				
Amosite	6,563·97	123,697	6,908·39	129,885
Chrysotile	258·48	9,149	380·45	11,958
Cape Blue	2,393·35	67,174	1,998·62	59,722
Transvaal Blue	1,278·26	30,160	324·03	9,139
Chrome	50,612·00	97,124	88,506·00	174,932
Copper—				
Ingot	4,437·15	193,849	3,217·55	136,242
Blister	—	—	6,681·47	259,659
Corundum	2,039·10	17,998	2,940·83	21,642
Fluorspar	1,872·00	5,020	1,614·00	4,888
Iron Ore	—	—	172,683·00	177,344
Magnesite	—	—	3,780·00	8,856
Manganese	166,092·00	289,062	151,423·00	347,715
Mica—				
Waste	558·00	1,419	549·00	1,687
Mineral Pigments—				
Ochres	3,651·00	12,064	773·00	4,322
Tin	352·36	48,687	266·05	35,989

The total production represents an increase of 18 per cent. in amount over the figure for 1940, the most significant increases having been in coal, iron ore, manganese ore, blister copper, mercury, magnesite and andalusite. The export statistics for the same period show that most of the increased coal output has been for local consumption, but that the exports of iron ore have risen to 172,683 tons, all of which went to the United Kingdom.

The most important base mineral production of South Africa from the point of view of export value is the manganese from the Postmasburg field. Five grades of ore ranging from 50 to 29 per cent. Mn and from 5 to 32 per cent. Fe are produced, and the total output of all these grades for the half-year was 245,919 tons compared with 212,713 tons in the corresponding period in 1940. Rather more manganese was consumed in South Africa than previously, and although there was a decline in the amount of exports, the f.o.b. value of the latter was higher at £347,715.

Another notable advance in the Union's mineral output made during the half year was that in copper, production having amounted to 13,572 tons compared with 7,448 tons, largely due to the recommencement of operations at the O'okiep mines of Namaqualand.

On the other hand, production of chrome at 72,406 tons marked a decline from 91,258 tons, but exports were more than maintained at 88,506 tons valued at £174,932 f.o.b., over £170,000 of which represented sales to America.

As will be seen from the above tables, other important items in South Africa's long and varied list of metallic and non-metallic mineral production include asbestos, andalusite, corundum, iron

pyrites, magnesite and tin, and although there has naturally been some fluctuation in the ratios of the amounts exported to those consumed in South Africa, it is satisfactory to note that altogether the Union's mineral exports showed a notable increase in value and were an extremely valuable contribution to the Empire's supplies of raw materials and to her resources of dollar exchange.

The Mineral Resources of the Domira Bay District, Nyasaland.—A geological survey, with special reference to economic deposits of minerals and material suitable for making millstones in an area of some 720 sq. miles in the Dowa district around Domira Bay on the western shore of Lake Nyasa, has recently been completed and has been described by W. H. Reeve in the *Annual Report of the Geological Survey Department of the Nyasaland Protectorate* for 1940.

This area is made up partly of Native Trust land and partly of European-owned estates bordering an area over which the British South Africa Co. owns the mineral rights. The region is one of crystalline gneisses and schists intruded by granites of two distinct ages, the whole overlain in the eastern part by residual sands and alluvium. In the western part of the area is found a series of quartzose schists and paragneisses conforming from their field occurrence and lithological characters to types common to the Basement Complex.

Gold.—Several minute colours of gold were obtained by panning the gravels in a small tributary of the River Lingadzi north-east of Nkunta village. Further prospecting of this stream, and loaming along its banks, were unproductive of more gold. Similarly, in a dry stream a mile north-east of Kangila village, rather coarse colours were recovered in several pans. In the main stream, large rafts of amphibole-schist are included in a strongly foliated granite, and they are intimately penetrated by numerous quartz veins and stringers. In a number of places these carry pyrites, and the basic inclusions in the granite are impregnated with the same sulphide along their junctions with the quartz veins. It is possible that the gold has its source in these acidic veins.

Mica.—Although a number of pegmatite veins have been seen to contain muscovite, more especially those emanating from the granite of Kasho Hill and penetrating the psammo-pelitic country rocks, almost without exception the plates are small though occasionally of good quality. Books greater than 2 in. in diameter are exceptional. Attempts to prove larger and better deposits were made without success in several places. On these results it appears that the mica is not likely to be of any commercial importance.

Graphite.—The pelitic schists and gneisses of the western portion of this region are principally micaceous or graphitic: graphitic types, in fact, are widespread, and there are numerous localities where the graphite is concentrated in massive form in the micaceous gneisses. Among these localities are: the track from

Chintembwe Mission to Nzandu village; the main scarp west of Chikwada, Mbobo, Matakenya and Chifulemba; near Chiwayu village; along the flanks of the Chirua River valley north-west of Mbobo village; along the Lingadzi valley and south-east of Kasho Hill. In the main, however, the graphite is more finely disseminated in micaceous gneisses. It is of fair quality generally, but commonly contains siliceous impurity.

Kaolin.—A deposit of whitish, powdery material known to the local natives as *nchenga yoyera,* situated on the eastern slopes of Kumbanchenga Hill, a mile east of N.A. Jere village, Kota Kota District, was examined. Simple blowpipe tests on the material confirmed its identity as kaolin, but it is somewhat gritty owing to the presence of fine-grained quartz. The original deposit was located in a tunnel-shaped excavation, penetrating some two or three yards into the slope of the hill. Other pits sunk at intervals of 120 ft. on either side along the contours of the hill, and above and below it on the slope, proved the presence of the same material. Its depth, no doubt confined to the zone of weathering, is uncertain. The micaceous gneisses of which Kumbanchenga Hill is composed are penetrated by abundant large pegmatite dykes containing extremely coarse felspar, and it is considered that the conversion of the felspars to kaolin on the scale observed may be attributed to pneumatolytic processes connected with the intrusion of the pegmatite bodies. Other signs of mineralization attributable to the same source are to be found in the presence of abundant muscovite and some tourmaline in the pegmatites and invaded rocks, while a quartzitic band on the western flank of the same hill is extensively pyritized.

Samples of this material have been collected with a view to submitting them to the Imperial Institute for quality and utility tests. At present it is used mainly by the local natives as a whitewash for the walls of their huts.

Galena.—The galena deposits investigated by the geologists of the British South Africa Company, about two and a half miles south of N.A. Chiwere village, were visited with the object of tracing any possible continuation of them into the Government lands. No such extension of the lode was observed within the limits of the area prospected.

Stream gravels.—In concentrates obtained from the panning of stream gravels throughout the region, garnet is a very common constituent, and kyanite in crystals up to ½-in. in length was conspicuous in several localities in the north, principally in concentrates from the Nkula stream. Zircon, epidote, hornblende, rutile and iron oxides make up the bulk of the remaining constituents of the concentrates.

During the reconnaissance of the Lingadzi valley and tributary valleys, a grain of wolfram was obtained in a concentrate from one of the streams south of Chifulemba village. Prospecting of this

and other streams in the neighbourhood did not reveal the presence of cassiterite or any of the other minerals usually associated with wolfram in tin deposits.

Millstones.—In the search for material suitable for the making of millstones in the Dowa District, the only locality likely to furnish such material was found to be on Kongwe Hill, about 10 miles north of Dowa. In the most favourable spots the rock is a fine-grained granite of an acidic character, free from biotite. Although such a stone is not ideal for the purpose, within the circumscribed area in which the material was required, it is the best procurable. The granite mass is traversed by three systems of joints, which would enable large, more or less rectangular, blocks to be quarried in the first instance, which could be trimmed to roundness at a later stage. Tests carried out on one block, of rather smaller dimensions than would be required for an actual working millstone, showed that trimming could be accomplished without any undue scaling or irregular fracturing of the rock. Other tests would, of course, be necessary to determine the degree of pulverization when in use.

In no other part of the area examined for mineral deposits was there observed any rock more suitable for millstones. One or two outcrops of quartzites were tested, but the material proved to be far too micaceous for the purpose.

Mining in Kenya.—The general outlook for the future for the mining industry of Kenya is quite promising despite the effects of the war. Although fewer mines are being worked, one or two new properties came into production during 1940, and the total output of gold during the year was 77,243 oz., valued at £648,783, representing a very substantial increase of £41,030 on the previous year, according to the *Annual Report of the Mining and Geological Department for* 1940 which was recently issued.

On the whole, private prospecting has decreased, but a promising feature for the future recently noticed has been the interest in Kenya's mineral resources evinced by mining men from other countries now serving with H.M. Forces in Kenya.

A grant of £15,000 from the Colonial Development Fund enabled geological activities to be carried out on an increased scale, especially in the Mtito Andei - Tsavo, South Kavirondo and Maragoli areas. This work has included a survey of the deposits of piezo-electric and optical quartz at Kinyiki Hill as well as a considerable amount of mapping and a survey of an important mineralised belt in South Kavirondo. During the year, also, special reports were prepared on the limestone of Muhoroni with special reference to its utilisation for local cement manufacture ; the magnesite deposits of Kinyiki Hill and Kipiponi Hill, the native sulphur of Naivasha and diatomite in Kedong Valley, as well as investigations into the crystal-bearing quartz veins of the Kitale district. The examination of an alleged

discovery of bitumen on the Athi plains showed that the existence of an economically workable deposit of bitumen was unlikely and has been abandoned.

The report also reviews such matters as the negotiations carried out during the year on the subject of the taxation of the gold industry, arrangements for refining made with the South African Government, and for the purchase of the gold production by the British Government, as well as new mining legislation and the suspension of prospecting for oil in Kenya during the year under review.

Iron Ore Deposits of Venezuela.—Imports of iron ore into the United States average about 2·4 million tons annually, an amount which perhaps seems insignificant when compared with the vast domestic production which is now at a rate of nearly 100,000,000 tons a year. Nevertheless, important iron mining industries have been developed in Central and South America to provide ore for the United States. Cuban ores were the first to be developed and before the first Great War supplied 1·3 million tons a year, but for the last 20 years Chile has supplied the greater part of American imports. The latest developments are in Venezuela where the Bethlehem Steel Corporation is at present developing a large deposit of high-grade iron ore at El Pao. The following review of the deposits of that country is compiled mainly from "The Pao Deposits of iron ore in the State of Bolivar, Venezuela," by E. F. Burchard, *A.I.M.M.E. Tech. Pub. No.* 295, 1930, which describes this deposit, and "Exploración preliminar de la Sierra de Imataca," by G. Zuloaga and M. Tello B, *Revista de Fomento No.* 19, pp. 397-430, December 1939, which gives the latest general account of the iron-bearing region.

The iron ore deposits of Venezuela, which are in many respects similar to those of Minas Geraes in Brazil, occur in the Sierra de Imataca, a range of mountains on the south side of the Orinoco running eastwards from Ciudad Bolivar into the delta. Two types of deposit are recognised, low-grade siliceous ores (itabirites) with about 45 per cent. iron, of which the reserves total many thousand million tons, and high-grade deposits with about 70 per cent. iron, of which at least two contain reserves of several million tons. The Pao deposits now being developed by Venezuelan Iron Mines, a subsidiary of the Bethlehem Steel Corporation, are of the latter type.

The history of the development of these deposits is as follows. The Imataca Mines at Manoa were opened up by a Canadian company (the Canadian Venezuelan Ore Co.) which eventually shipped 69,000 tons of ore to the United States in 1912 and 1913; shipping difficulties were encountered, however, and no more ore was exported. This deposit is not large and is now considered to be of minor importance. About this period the same company

investigated deposits at Piacoa in some detail, but no ore was mined, and five other deposits were also described. In 1925 or 1926 the Pao deposit was discovered and extensive prospecting was carried out during the period 1927-29. The Bethlehem Steel Corporation acquired the deposit in 1933 and preparations for mining are now well advanced. In 1939 at the request of the Government, a preliminary geological investigation of the Sierra de Imataca was made by Venezuelan geologists. They reported the existence of vast reserves of low-grade ore which might be amenable to magnetic concentration, and also the presence of high-grade deposits including a newly-discovered deposit at La Represalia considered to be large.

El Pao Deposit.—El Pao is situated 19 km. N.W. of Upata and 30 km. S. of the port of San Felix on the Orinoco. The mining claims cover an area of about 6 by 7 miles, the ore outcropping on mountain crests that reach altitudes of up to 1,930 ft., and traceable down precipitous slopes for nearly 400 ft. vertically. Drilling has indicated that ore extends a further 400 ft. below the surface at one place at least. The main outcrop has the form of a crude figure 8, and the shape of the orebody is not easily interpreted, but it appears to be a steeply inclined bed. It is bordered by ferruginous quartzites of the itabirite type and underlain by granitic rocks, and in places is overlain by serpentine and gabbro. The outcrops cover an area of 28 acres, and in 1930 the reserves were estimated as 15,000,000 tons of ore in sight and 20,000,000 tons of probable ore. A more recent estimate gives the reserves at 17,000,000 tons, and presumably this refers to ore in sight only.

The ore is predominantly a bright steely grey hard rock of fine to coarsely crystalline texture, consisting of haematite with some intimately admixed magnetite. Analyses, based on prospecting in 1928-29, which included 15,000 ft. of diamond-drilling, showed an iron content generally from 65 to 70 per cent., although in some instances owing to the presence of magnetite more than 70 per cent. iron is present. Phosphorus is generally below the Bessemer limit, and sulphur and titanium are low. Silica is unusually low, and alumina is frequently the principal impurity, in some cases being present as corundum. Careful surface sampling gave the following results (on dried samples):

	Fe.	SiO_2.	Mn.	Al_2O_3.	TiO_2.	S.	P.
A.	68·00	0·36	0·27	0·09	0·12	0·01	0·051
B.	69·25	0·38	0·09	0·33	0·08	0·02	0·028
C.	69·05	0·46	0·08	0·28	0·20	0·027	trace

A—Composite of 13 *samples over a distance of* 1,400 *ft.*; *average width of ore,* 76 *ft.*
B.—Composite of 6 *samples over a distance of* 800 *ft.*; *average width of ore,* 360 *ft.*
C.—Composite of 5 *samples over a distance of* 1,000 *ft.*; *average width of ore,* 161 *ft.*

Thirty other samples gave an unweighted average of 67·64 per cent. Fe, 0·25 per cent. Mn, and 0·0355 per cent. P. A series of 10 drill core samples from depths of 35 to 420 ft. gave the following

range: Fe, 67·52 to 71·33, Mn, 0·02 to 0·12, P, 0·013 to 0·030, S, 0·01 to 0·118, SiO_2, 0·09 to 0·64, and Al_2O_3, 1·01 to 4·04 per cent.

The original plans suggested for the exploitation of the ore included the construction of a normal gauge railway from the mines to San Felix, and the construction of an electric power station at falls on the Rio Caroni 6 miles from San Felix to supply the mines and electrify the railway. The ore would probably be shipped down the Orinoco in shallow draft boats in order to cross bars affording not more than 6 ft. to 8 ft. of water, and transhipped to ocean-going vessels at some port on the Gulf of Paria in Venezuela or Trinidad.

In 1939 levelling for the railway from the mine to San Felix, a distance of 56 km., had been completed, and a series of echo soundings of the depth of the Orinoco suggested that boats of large tonnage could reach San Felix.

Early in 1941 the Bethlehem Steel Corporation reported that they were proceeding with the development of the property with a view to starting shipments in about five years' time. Approximately 30 miles of road and 40 miles of railway will have to be built, and rolling stock, mining plant, loading docks, power plants and other facilities provided.

Other High-grade Deposits.—The Venezuelan geologists who investigated the region in 1939 suggest that the La Represalia deposit has great economic possibilities. It is situated 15 km. S.W. of Sacupana, a town on the Orinoco 60 km. E. of Piacoa. It was discovered by Sr. Simón Piñero and was being blocked out at the time of the investigation. The quality of the ore is identical with that of El Pao, and the outcrop is of considerable extent.

Other occurrences of high-grade ore are reported from the following localities, listed in order from east to west:

La Margarita and Las Piedras on the Rio Acure, 45 km. S.W. of Manoa. (A deposit described earlier as La Escondida is in the same district and may be the same deposit.)
Manoa, on the Caño Corosima, 90 km. E. of Piacoa.
On the Rio Aroi, which flows into the Caño Corosima.
On the Rio Toro.
Santa Catalina on the Orinoco 20 km. E. of Piacoa.
La Imperial and Los Castillos on the Orinoco 35 km. N.E. of San Felix.
Monte Cristo, 30 km. E. of Ciudad Bolivar.

Some of these deposits, such as those at Manoa and Rio Aroi are considered to be of little importance. In other cases the high-grade ore is only superficial, being a "Canga" or surface enrichment of the low-grade siliceous ores described below, and similar to the Canga of Brazil. The region is characterised by dense vegetation, and many of the deposits are only poorly exposed. The following

are analyses of these ores, most of them made before the last Great War:

	Fe.	SiO_2.	Mn.	P.	S.	TiO_2.
Manoa, Imataca (average 3 cargoes)	66·53	1·81	—	0·031	0·045	0·139
Piacoa "Canga," (average 6 samples)	59·37	7·25	0·66	0·192	0·072	0·84
Piacoa "Canga" (average)	61·00	3·85	8·50	1·260	0·037	0·60
Los Castillos	59·00	6·50	0·10	0·112	0·052	0·90
Santa Cantalina	64·00	1·20	0·07	0·140	0·022	0·30

Low-grade Deposits.—In the Sierra de Imataca the rock known as itabirite is very widely distributed, and the Venezuelan geologists maintain that its economic possibilities as a low-grade iron ore should be considered. This rock, characteristic of the iron-bearing formations of Minas Geraes where it was named, is a ferruginous quartzite, and in this region it is found to contain about 45 per cent. of iron. The reserves of ore of this type must total many thousands of millions of tons. The Piacoa deposit is chosen to illustrate the enormous extent of these rocks. The Cerro de Piacoa rises from the savanna about 4 km. from Piacoa on the Orinoco. It is 150 metres high in the centre and 1,200 by 5,000 metres across at the base and consists entirely of itabirite. Its content is estimated as 600,000,000 tons above the level of the savanna. The itabirite is remarkably uniform in composition with an average of 45·7 per cent. iron. The Venezuelan government has been urged to investigate the possibility of working this class of deposit and of concentrating the ore, perhaps by controlled roasting to reduce the haematite to magnetite followed by magnetic separation. There are several deposits similar to that of Piacoa, but the latter is particularly favourable for investigation as it is not covered with vegetation and is readily accessible.

The Magnesium Industry in the United States.—The exceptional expansion of the aircraft producing industry in the United States has given rise to an unprecedented demand for magnesium metal, and the consumption in 1940 represented an increase of 75 per cent. over the previous year according to data issued by the U.S. Bureau of Mines.

Primary and secondary metal consumption accounted for 11,531,000 pounds of magnesium, of which 64 per cent. was used by the manufacturers of magnesium-rich alloy castings, sheet, and extruded products for the aircraft, automobile and other industries. Magnesium-aluminium alloy manufacturers accounted for 31 per cent. of the total magnesium production, the major part of which must also be accredited to the aircraft industry. The balance of the consumption was accounted for by such miscellaneous uses as a scavenger and deoxidiser in metallurgical processes, in the production of other magnesium-bearing alloys and in the manufacture of chemicals, etc.

A remarkable fact in the analysis of the figure of 7,363,000 lb. of magnesium used in the manufacture of structural products is the loss of 1,979,530 lb. or 27 per cent. during the manufacturing processes owing to the susceptibility of the metal to oxidation at temperatures above its melting point.

The production of structural and non-structural magnesium products during 1940 represented an increase of 125 per cent. on the figures for 1939. In the last quarter of the year, the aircraft industry began to require all the output of magnesium-alloy products which could be manufactured, and actual formal priority for the industry was announced on March 3, 1941.

This increased demand for magnesium products has led to the construction of new plants and to the extension of the existing ones in the United States. The Dow Chemical Company increased the capacity of its Michigan plant to 13,000,000 lb. per annum early in 1940 and during the current year expects to produce 30,000,000 lb. and 52,500,000 lb. in 1942. A plant for the production of magnesium from sea-water at Freeport, Texas, came into production in January 1941, whilst the plant of the Todd-California Shipbuilding Corporation at Permanente near San José, California, was expected to commence production in August 1941 and to have an output of 24,000,000 lb. by 1942. When these plants are in production it is expected that their combined capacity will be of the order of 76,500,000 lb. per annum, but the programmes of the Office of Production Management calls for an increase in capacity to 400,000,000 lb. annually.

At the same time as this increase in the capacity of existing plants and the construction of new ones has been going on, the manufacturers of magnesium products have also been increasing their output capacity to meet the requirements of the United States national defence programme.

World Diamond Industry.—Notwithstanding the repercussions of the war, the diamond industry had a comparatively satisfactory year in 1940 according to S. H. Ball, who makes his familiar annual review of the industry in the *Jewellers' Circular-Keystone*, from which the following has been abstracted.

The expansion in the total diamond production by weight is accounted for by the demand for industrial diamonds which has increased eightfold in the last 30 years. The output of cuttable material, on the other hand, declined by some 20 per cent. during the year under review. The sales of rough diamonds by the Diamond Trading Company at about £6,000,000 during 1940 were about the same as in the previous year, and although stocks of rough are adequate, it is believed that a shortage of the smaller cuttable goods will appear in the United States in the near future. This class of goods has doubled or even quadrupled in price since

the beginning of the war, whilst fine stones of the larger sizes have increased in price by 10 to 20 per cent.

Owing to international government restrictions, the buying of diamonds as an investment has not been evident during this war to the same extent as in the last. There were, however, waves of buying in each European capital coincident with the approaching crises in the corresponding country. The cutting industry was naturally completely disorganised by the invasion of the Low Countries. A re-start has been made by those cutters remaining in and those forced to return to Antwerp and Amsterdam, with diamonds captured from refugees, but neutral observers do not confirm that the recommencement of the industry is on the scale claimed by the report that between 4,000 and 5,000 men are at work. It is believed that some 500 cutters reached England from the Low Countries, and a cutting industry has been established in a number of centres in the United Kingdom, notably in London, Brighton, Birmingham and Bangor. At one time there were about 700 cutters in the U.S.A. and 600 in South Africa, and though these numbers declined during the years of depression, they have increased to about 500 again in each of these countries. In addition to these, there are also cutting industries in Porto Rico, Palestine and Brazil.

Statistics of production for the year 1940 are not so reliable as in normal years, and necessarily include a number of estimated figures, as shown in the following table:

WORLD PRODUCTION OF DIAMONDS
(*Carats*)

	1938.	1939.	1940.
Africa—			
Angola	651,265	690,447*	785,000*
Belgian Congo	7,205,620	8,344,765	10,900,000*
French Equatorial	19,644	16,000*	16,000
French West	61,928	56,314	75,000*
Gold Coast	1,296,763*	1,087,652	825,000*
Sierra Leone	689,621	600,000*	600,000*
S.W. Africa	154,856	36,010	30,017
Tanganyika	3,576	3,445	2,250*
Union of South Africa	1,238,608	1,249,828	523,434*
Brazil	235,000*	350,000*	325,000*
British Guiana	32,522	32,491	26,764*
Elsewhere	34,200	19,000	31,750*
Total	11,623,603	12,485,952	14,140,255*

* *Estimated.*

The predominant position of South Africa in the diamond industry has been menaced for some years by the production from many important alluvial fields in other parts of the world, and that from the Belgian Congo is by far the largest of any single country on the basis of caratage.

In addition to the figures shown in the above table, there is a small output from Vichy French Guinea, half of the production of

which had to go to Germany, and also a small production from French Equatorial Africa, which is Free French.

The Brazilian diamond industry, with a demand chiefly from German sources, had a prosperous year, and of the estimated output of 325,000 carats, 25,000 carats were reported to be carbonados.

Of Venezuela's estimated total production of about 30,000 carats, 23,435 carats were of industrial stones.

Base-exchange Water Softeners from Coal.—It is a matter for regret that the term zeolite should have been so extended that it now covers many substances which have no chemical or mineralogical relationship to the true zeolites. The zeolites proper form a well-known group of chemically related minerals, hydrous silicates of aluminium with calcium or sodium, sometimes with potassium, barium and strontium, which were called zeolites because they characteristically fuse with intumescence in a blowpipe flame. Some minerals of this group happen to possess the property of softening water by base exchange, and a number of similarly composed artificial products have been prepared which possess this property in a marked degree and are employed commercially as water-softeners. They are known as artificial zeolites. The quite unrelated natural mineral glauconite also possesses this property of cation-exchange and because it is used commercially for the same purpose it is often referred to, quite incorrectly, as zeolite. Subsequently many other substances have been artificially prepared for use as ion-exchange materials and unfortunately these also are now commonly referred to, not only in commerce, but also in scientific literature, as zeolites. This way lies confusion.

One class in particular of these substances—the so-called carbonaceous zeolites—has been developed with considerable success; they have passed the experimental stage and are now available commercially. These products, which may be made from coal, have many advantages over the silicate softeners. They possess high exchange values, are of rugged constitution and can act as exchangers either of sodium or of hydrogen according to whether they are regenerated with common salt or dilute acid. Since these carbonaceous products are non-siliceous, their special field of usefulness lies in the treatment of boiler-feed water where dissolved silica from other types of base-exchanges is a nuisance. Reference was made to the development of these substances in a note in this BULLETIN, 1937, **35**, 90-92, since when a great deal of further work has been done.

A recent report on the preparation and properties of carbonaceous base-exchangers deals with the work done by the U.S. Bureau of Mines on a number of samples of bituminous coals from Kentucky, West Virginia, Alabama and Indiana. (Carbonaceous Zeolites from Bituminous Coal, by S. J. Broderick and Dale Bogard, *Ind. Eng. Chem.* **33**, No. 10, Oct. 1941, 1291-96.) Instead of the usual method

of activation, by digesting the coals for three hours with concentrated sulphuric acid at 100° C., the coals were treated with sulphur trioxide at 150° C. until saturation was reached, the periods ranging from 3·3 to 7·5 hours according to the experimental conditions. The resulting materials were tested according to the method laid down by the Zeolite Committee of the American Water Works Committee and the results showed the products to be superior to those previously obtained by the same workers when using sulphuric acid as the activator (*Rep. Invest. No.* 3559, *U.S. Bur. Mines*, March 1941). The products gave working capacities of 9,500 to 12,800 grains of calcium and magnesium per cubic foot of exchanger.

An attempt was made to correlate the exchange values obtained with the physical and chemical characters of the coals tested in order to discover what property determines the suitability of a coal for use as a raw material for making base-exchange water softeners. This investigation, however, led to no conclusions. Little is yet known of the reactions which occur during the sulphonation of coal.

Purification of Indian Glass Sands.—The glass-making industry of India, which is principally located in the United Provinces, obtains its sand either from Bargarh and Loghra near Naini or from Sawai Madhopur in Jaipur State at a pit price of about Rs. 3 or 4 per ton whilst those factories located in Calcutta and Bombay have to pay a delivered price of from Rs. 15 to Rs. 25 per ton owing to the cost of transport. Other deposits of sand suitable for glass making and located nearer points of consumption are known in many parts of India, but none of them are used owing to their iron oxide content being higher than those already worked and the fact that purification of glass sands has not hitherto been practised in India. Even the sands which are utilised in India have a higher iron content than those commonly in use in other countries, and since a higher proportion of decolourising material has therefore to be employed, colourless glass made in India is usually dim in appearance.

The now well-known Adams's process of washing sands with a solution of acid solium oxalate and ferrous sulphate at 80°-90° C., which is successfully applied on a commercial scale to the sand of King's Lynn, England, has recently been applied on an experimental scale to a number of Indian sands by B. J. Hegde, the results of which have been described in *Bulletins of Indian Industrial Research*, No. 22, Delhi, 1941, from which these abstracts are taken.

The fundamental principle of this process is that ferrous salts are more soluble than the corresponding ferric salts. The hot solution of acid solium oxalate and ferrous sulphate reduces the iron oxide of the coating on the sand grains to the ferrous state and can therefore easily be washed out.

The technique employed on the experimental scale is to treat 200 gms. of the sand with 0·5 gm. of the acid sodium oxalate in

90 c.c. of water and heated to 80°-90° C. with continuous stirring. To this 0·2 gm. of ferrous sulphate in 10 c.c. of water is added, and the stirring continued for a further 3 minutes. After decanting this liquid the sand is twice well washed with water, dried and the remaining iron content determined.

With one exception, a very substantial reduction of the iron oxide content of nine Indian sands was affected, resulting in a specification well within that of the British Society of Glass Technology.

For application on the commercial scale, it is recommended that the cheaper normal sodium oxalate acidified with sulphuric acid should be used and that sun drying, which is possible in India, should be employed.

The solution decanted from the sand consists of acid sodium oxalate together with iron and aluminium compounds and other impurities. This solution is made just alkaline with dilute sodium hydroxide when the compounds of iron and aluminium are precipitated, after which the clear liquid, consisting of normal sodium oxalate, is siphoned off and restored to correct strength and acidity by the addition of an estimated amount of fresh sodium oxalate and sulphuric acid.

The author has estimated the cost of applying this process to Indian sands on the basis of peace-time prices of chemicals and concludes that as mechanical equipment is not essential, the process is particularly suitable to Indian conditions.

Calcite and Fluorspar for Scientific Instruments.—The carbonate and fluoride of calcium are by no means uncommon in nature and in the form of limestone and fluorspar, enormous tonnages are used annually in all industrial countries.

Particularly clear and well crystallised varieties of these minerals are, on the other hand, comparatively speaking, quite rare, such material being used by optical instrument manufacturers in the production of certain lenses and prisms. Nevertheless, the amount so used is by no means large, and it will be appreciated that few, if any, deposits of these minerals would repay operating solely for the recovery of such grade of crystals. Those, therefore, who either casually or in the course of working properties for industrial grades of these minerals, come across promising crystals, should take particular care of them as they can be profitably disposed of. No special knowledge of treatment or preparation other than the careful removal of obviously extraneous matter, is required, and as the quantities involved are unlikely to be large the material can be despatched and sold through the post.

Material which is acceptable by optical instrument makers commands a fair price and as is similarly the case with rock-crystals (for piezo-electric purposes) a not inconsiderable proportion of the

market demand is regularly met by what may be termed casual supplies.

Some further information about these minerals, largely based on a recent *Information Circular* (No. 6468 R.) of the U.S. Bureau of Mines, by H. H. Hughes, may therefore be of interest and value to those who are likely to encounter calcite and fluorspar of optical grade.

Iceland spar is the name usually given to highly pure, transparent, well-crystallised varieties of calcite and is named after the country in which it was first discovered and from which supplies largely originated for many years.

The principal use of Iceland spar is in the manufacture of the so-called nicol prism, a device for producing light vibrating in one plane only and the examination for diagnostic purposes of such plane-polarised light after its passage through or reflection from minerals, metals, solutions, etc. Nicol prisms are therefore essential parts of all polarising microscopes, dichroscopes, saccharimeters, photometers, calorimeters and polariscopes, etc. The minimum requirements for these optical applications are perfect rhombs of clear crystals weighing about $\frac{3}{4}$ oz., a size obtainable from a crude crystal of about 2 oz. Prices for Iceland spar are usually a matter of private negotiation and manifestly depend upon the size, quality and quantity offered. In the United States, prices have fluctuated in recent years between \$7 and \$35 per lb. A minor amount of Iceland spar is also sold to museums, teaching institutions, etc., at prices varying between \$1 and \$5 per lb. and to manufacturing chemists at about \$1 to \$2 per lb. for use in the preparation of standard solutions.

In the celebrated occurrence of this mineral on the east coast of Iceland, the best crystals are found embedded in a clay resulting from the decomposition of a series of basalt lavas, and the finest specimen ever obtained from this locality is probably that in the possession of the British Museum. During the last war, operations at this deposit had to be discontinued, and the quarry was flooded in the belief that the crystals would thus be protected from the weather. On subsequent re-opening, it was found, however, that the material available was markedly inferior to the pre-war product, and it is for this reason that the type locality for Iceland spar has declined in importance as a source of crystals of optical grade.

South Africa has in recent years become one of the important sources of supply (see this BULLETIN, 1937, **25**, p. 88), and spasmodic supplies have also originated from Spain, Canada, and South America, as well as from a number of localities in the United States.

In a similar way to calcite, industrial qualities of fluorspar for use in metallurgy and in the manufacture of hydrofluoric acid, glazes, enamels and opalescent glass are produced on a large scale, and the material is comparatively low priced. Special material of sufficient size, usually a minimum of $\frac{1}{4}$ in. diam., exhibiting well-

developed crystalline form, and absence of cloudiness or strong colouration, fractures or twinning, finds application in scientific instruments, notably in the manufacture of lenses in microscope objectives, in telescopes and in the prisms of spectrographs.

Fluorspar, though found most commonly as veins in or as replacements of limestone, may be encountered under a wide range of geological conditions so that no general guide can be given as to where high-grade material is most likely to occur. Prices for optical grades of fluorspar have, like those for calcite, varied widely during recent years between \$1 and \$10 for average quality crystals, though individual crystals have been sold for as much as \$10 each.

Substitutes for both calcite and fluorspar have recently been produced synthetically by the continuous crystallisation of such suitable molten salts as lithium fluoride, sodium chloride, potassium bromide, etc., but no information is as yet available as to the extent, if at all, to which these are actually replacing naturally-occurring material.

BOOK REVIEWS

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METALS AND ALLOYS. Fourth Edition. Pp. xix + 156, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: The Louis Cassier Co., Ltd., 1941.) Price 15*s*.

Metals and Alloys is a work of reference commonly found on the bookshelves of those concerned with the metallurgy of the non-ferrous metals and of the many others who are interested in their uses.

The scope and format of this familiar work is therefore well known and does not require more than brief recapitulation here. As in previous editions, the alloys are tabulated alphabetically under the trade name in the case of proprietary alloys, under the group name in the case, for instance, of the brasses and bronzes, under various non-proprietary names like Muntz metal which have come into general use, or under "duty names," such as optical bronze, valve seats, turbine sleeves, etc. The constituents of the alloys are given either as percentages or as a range in percentages in columns, one each for aluminium, chromium, copper, iron, lead, magnesium, nickel, tin, or zinc, the amounts of other constituents such as antimony, cobalt, manganese, phosphorus, silicon, tungsten, etc., where present, being shown in a miscellaneous column. Here also are to be found melting points in the case of certain gold and silver solders.

For the purpose of these tables the publishers have ruled out as being ferrous, all alloys containing more than 50 per cent. of iron.

The work concludes with a table of the chemical symbol, colour, international atomic weight, specific gravity, specific heat, electrical and heat conductivity, and the melting and boiling point of each of the metals.

In this edition, the compilers have not been afraid to do considerable weeding out, particularly of a number of unnamed alloys, the specific uses of which are unknown. The fact, therefore, that the present edition contains the compositions of some 3,700 alloys as compared with the 4,600 in the 3rd edition and supplement, is no direct guide to its up-to-date nature or to the amount of revision which has been entailed in the preparation of the work, which contains a very large number of alloys not incorporated in previous editions.

The fourth edition of *Metals and Alloys* has been published in green covers, thus conveniently distinguishing it on the bookshelf from the earlier editions in red. Although a reviewer cannot check all the data in a work of reference of this nature, it appears to be remarkably free from typographical errors and omissions, and to be more reliable than previous editions. Although admittedly grouping is very difficult in a reference book of this kind it would appear that more cross references might have added materially to its usefulness.

The latest edition will be found to be even more useful than the previous editions must have been to many interested in the technology and uses of the industrial metals and of alloys other than those which are predominantly ferrous in composition. It may not be generally known that there is also to be found in this work something of interest and usefulness to the numismatist, the archæologist and the antiquarian who may require to know the composition of such objects as coins, historic axe heads, Roman needles and swords, ships' nails, famous bells, or celebrated statues.

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EXHIBITION GALLERIES, FILM LIBRARY AND CINEMA

NOTES

Exhibition Galleries.—The Galleries still remain closed to the general public but are available for visits of organised parties who make written application in advance to the Secretary. The exhibits are also available for inspection by inquirers referred by the Plant and Animal Products Department and the Mineral Resources Department.

During the past quarter the following distinguished visitors have been shown the Courts in which they are particularly interested:

On August 21 Mr. Vincent Glenday, C.M.G., O.B.E., Governor of British Somaliland, visited the Galleries and was shown the exhibits in the Somaliland Court.

On September 5 the Rt. Hon. Earl Stanhope, P.C., K.G., D.S.O., M.C., Chairman of the Standing Commission on Museums and Galleries, with Mr. G. M. Young, C.B., and Mr. W. C. Chesterman, respectively Member and Secretary of the Commission, paid a visit to the Galleries accompanied by the Director.

On September 20 the Rt. Hon. L. S. Amery, M.P., Secretary of State for India, with Mrs. Amery, attended the reception of the Society of Yorkshiremen in London in the Exhibition Pavilion. They were received by Sir John Woodhead, K.C.S.I., C.I.E., Chairman of the Society, and Sir Harry and Lady Lindsay.

On October 3 H.M. King Peter of Yugoslavia visited the Exhibition Galleries with the Director and Lady Lindsay. His Majesty was accompanied by one of his Ministers, and by Mr. Rendel, British Minister to the Court of Yugoslavia, Mrs. and Miss Rendel.

On October 23 the Rt. Hon. Lord Huntingfield, K.C.M.G., Governor-Designate of Southern Rhodesia, paid a visit to the Southern Rhodesia Court, and was also interested in the Australian Court as an ex-Governor of the State of Victoria (from 1934 to 1939).

On October 30 the Honourable U. Saw, Premier of Burma, had a private view of the Burma Court, and afterwards met Friends of Burma in the Exhibition Pavilion where the guests were received by Mr. Harcourt Johnstone, M.P., Secretary of the Department of Overseas Trade and President of the Board of Governors of the Imperial Institute, the Director and Lady Lindsay. Films of Burma were shown in the Cinema Hall of the Institute.

The following organised parties have attended lecture demonstrations in the Galleries, conducted either by the Director, by an Exhibition Officer, or by the Guide Lecturer, and have afterwards been shown related films in the Cinema:

On August 11 a contingent of Indian Pioneers.
On August 20 and 22 a party from the Guards Brigade Headquarters.
On August 23 members of the Cypriot Women's League, the Cypriot Brotherhood and the Cyprus Association.
On August 25 a party from Denham School, Middlesex.
On August 26 and 28 a contingent of the Royal Suffolk Hussars.
On August 30 evacuees from Gibraltar.
On August 31 Indian Labour Trainees.
On September 3 a party from Woodridings School, Hatch End, Middlesex.
On September 8 and 11 officers of the Royal Artillery, Woolwich.
On September 13 members of the South London Botanical Institute.
On September 16 officers of the Royal Artillery, Woolwich.
On September 20 the Society of Yorkshiremen in London.
On September 25 officers of the Royal Artillery, Woolwich.
On September 27 Belgians from the Putney War Refugee Committee.
On October 1 the East India Association.
On October 3 members of the Association of Polish Engineers.
On October 4 members of the Cypriot Women's League.
On October 7 a contingent of the R.A.S.C.
On October 10 a party of Overseas Troops.
On October 11 a contingent of W.A.A.F.S. (Air Ministry Unit).
On October 13 a party from Southburn Road School, Enfield.
On October 14 and 15 a contingent of the R.A.S.C.
On October 17 members of the Association of Polish Engineers.
On October 18 a party from the Hampstead War Refugee Committee.
On October 21 a contingent of the R.A.S.C.
On October 24 a party of military officers detailed for service in the East.
On October 31 members of the Association of Polish Engineers.

New Exhibits.—In present circumstances it is very difficult to procure material for new exhibits, either from home sources or from overseas. Improvements are, however, carried out wherever possible by the use of store material or the rearrangement on new lines of the existing exhibits, supplemented by such new specimens as we are fortunate enough to receive.

In the Burma Court, the story of tin and tungsten—they occur together in Burma—is told by means of photographs and specimens displayed in a table-case. The exhibit traces the winning of the

ore, its purifying and the treatment by which the metal tungsten is obtained, and further shows the value of tungsten in giving hardness and toughness to machine tools, enabling them to work at enormous speeds and to stand up to heat which would soften tools of ordinary steel. Although complete in itself, this exhibit only represents the winning of the mineral in Tavoy and Mergui. In order to effect a full representation of this industry in Burma the inclusion of an exhibit of the industry at the Mawchi mines in the Karenni State was considered desirable. Through the good offices of Messrs. R. Annan and C. E. Jobling, Directors of Mawchi Mines, Ltd., specimens of ores from the Mawchi Mine have been obtained from Burma, together with photographs of views of the mine to form the basis of a small diorama, the construction of which by Mr. Herbert H. Cawood is now in progress. When completed the diorama will be installed in the Court and will be associated with the specimens of ores and supported by drawings showing the workings in the mine.

Tungsten ore or wolfram is one of Burma's most important war minerals. During the last war Burma became, after China, the world's largest producer of wolfram and to-day Burma still occupies with China a leading place in the world production of this tungsten-yielding mineral.

To complete the story display of Indian carpet weaving described in this BULLETIN, 1940, 38, 519, a small diorama of a carpet saleroom in London has been made by Mr. Herbert H. Cawood. This will be added to the existing series of three dioramas and will take the place of the samples of wool at present in the showcase. The four dioramas will then tell the story under the following headings: (1) A Sheep Farm in India: (2) Sheep Shearing in India; (3) Carpet Weaving in India; (4) Indian Carpets in a London Saleroom.

The reorganisation of the Cyprus Court has been continued, with the assistance of the Commissioner for Cyprus; and although no further consignments of the series of exhibits promised by the Cyprus Government have arrived, more attractive displays of those already received have been made. The proposed models of a cotton plant and a tobacco plant for which drawings have been received from Cyprus are in abeyance as the artist concerned is now with H.M. Forces.

In the Malta Court the collection of photographs illustrating the scenic attractions of the island has been overhauled and many additional photographs have been added through the kind co-operation of the Trade Commissioner for Malta.

In the West Indian Court two showcases have been reconstructed and in them have been staged attractive displays illustrating respectively the use of West Indian ornamental seeds in the production of beadwork, necklaces, bags, caps, etc., and the local manufacture of hats, mats and baskets from strips of palm leaf and corn-cob husks.

To the Canadian Court has been added a small exhibit dealing with the production of Canadian animal glues from by-products of the meat industry.

A collection of modern Malay silver-work, formed by the late Mr. H. L. Linnell, who spent the greater part of his life in Malaya as a planter, has been bequeathed to the Imperial Institute by Mr. Linnell's sister, the late Mrs. E. A. Ford. The silver-work comprises twenty-seven pieces, largely bowls with or without covers, and is displayed in a showcase in the British Malaya Court where it serves to illustrate the present-day craftsmanship of the Malay silversmith. The examples show characteristic freedom of design and boldness of form. All the pieces are typically light in weight, having been beaten very thin, and they bear, as with Mohammedan work generally, no trace of animal life in their repoussé and incised decoration. Forming a background to the display is a fabric of polished black cloth stamped with a design in gold, such as is used chiefly by Malay royalty and nobility on high days and holidays.

Imperial Institute Stories of Empire Products.—In the last issue of this BULLETIN, 1941, **39**, 212, reference was made to the completion of the first series of six posters and illustrated descriptive leaflets dealing with the production and uses of some typical colonial products, and also to the preparation of a further series.

The Colonial Office have now provided funds for the second series and the subjects to be dealt with are Malayan rubber; East African sisal; Ceylon tea; East African coffee; Nigerian hides and skins; and British Guiana rice.

No. VII, "Malayan Rubber—From Trees to Tyres, Toys and Telephones," has already been issued and, as its title suggests, traces the story of the production of rubber from the time it leaves the tree as latex, through its various stages of manufacture, until, in one form or another, it reaches the consumer in the street, the home, the office, or the sports ground.

No. VIII, which treats of East African sisal in a somewhat similar manner, is in active preparation.

Empire Lectures to Schools.—The Imperial Institute scheme of Empire lectures to schools, which was referred to in the previous issue of this BULLETIN, was revived in September. During that month 43 lectures were given to audiences aggregating over 6,000 persons. The number of lectures delivered during October amounted to 82 and the audiences exceeded 13,000.

The co-operation of educational authorities throughout the country has been obtained, and the popularity and value of these lectures has been shown by the large number of letters of appreciation which have been received. It would appear from the increase in the October figures that the lectures are supplying a long felt need for first-hand knowledge of our overseas Empire.

Central Film Library.—As was anticipated in the last issue of the BULLETIN, 57 new films have been added to the Library by the Ministry of Information and more than 1,000 prints of these films have been put into circulation. The new titles included nine films about Empire countries.

A careful survey has been made of the films on the Empire already in the Library and of other films which might be added and it is hoped to strengthen the Empire section of the Library very considerably by the beginning of 1942. The demand for films from all sections of the Library continues to increase and the problem is to find additional suitable films for inclusion in the Library. In the search for new films the Library is being considerably helped by the High Commissioners for the Dominions, backed by a generous grant from the Imperial Relations Trust.

Empire Lantern Slide Library.—The circulation of lantern slides of the Empire to schools, women's institutes, societies and army educational authorities during the period August, September and October totalled 9,230 and the details are shown in the following table:

	August.	September.	October.
Canada	—	350	650
Australia	—	250	850
New Zealand	—	150	400
South Africa	—	150	150
India	50	400	700
Burma	—	—	150
Territories of the Colonial Empire	150	750	1,900
Products of the Colonial Empire	150	600	250
General Tours of the Empire	50	200	450
History of the Empire	—	60	420
	400	2,910	5,920

During the month of August there was obviously very little demand because the schools were shut for holidays and societies prefer activities which take them out of doors.

A new picture talk on Hong Kong was written by Mr. G. S. Wilby, of the Education Department, Hong Kong, and has been printed. The talk begins with a description of the geographical features of the Colony and its importance as a naval base and commercial centre in the Far East. The construction difficulties of building on the Peak are illustrated by pictures of the steep streets and narrow winding roads. Contrast is shown between East and West in a series of pictures of Chinese shops displaying silk banners, street barbers at work, rickshaws, sedan chairs and coolies carrying loads in panniers. These are followed by shots of the sky-scraper buildings, the new Shin Mun reservoir and filter beds, the Peak tramway and the European section of the city. Junks and sampans introduce the fishing industry and modern steamers the carrying

trade. Typhoon damage, irrigation and the rice industry are followed by pictures of the celebrations on the occasion of King George V's Jubilee.

In a new talk on the Anglo-Egyptian Sudan, which has also been printed, Mr. J. G. Matthew, C.M.G., O.B.E., makes a broad survey of the area, boundaries, population and physical features of the country. The natural division is made between the northern half with its Mohammedan Arabic-speaking population and the southern half inhabited mainly by pagan negroid tribes. A brief historical survey is based on the Gordon statue at Khartoum, the s.s. *Bordein* and the Governor-General's palace. The Arabic houses of Suakin, with their lattice windows, the pilgrims for Mecca, the water carriers, the ploughing with oxen, transport by camel and the native style of boats used on the Nile bring out the way of life followed in the north and east, while the southern Sudan is illustrated by pictures of the various tribes, the Sennar dam and irrigation schemes, cotton growing in the Gezira, and the various crops cultivated by the natives. Locusts, crocodiles, elephants, rhinoceroses illustrate the fauna of the Sudan, and finally Mr. Matthew concludes his talk with a summary of the work of the missionaries, school teachers, administrators and scientists in promoting progress and development.

Colonial Visitors.—The following is a list of officers on leave from the Colonial Empire who have visited the Institute during the period August-October 1941.

AUGUST

Dr. I. W. M. A. BLACK, Assistant Chemist, Department of Agriculture, Nyasaland.
V. G. GLENDAY, C.M.G., O.B.E., Governor, British Somaliland.

SEPTEMBER

Nil.

OCTOBER

Captain H. P. DIXON, District Commissioner, Administrative Service, Gold Coast.
D. STEVENSON, Senior Assistant Conservator of Forests, Gold Coast.
Miss M. E. WESTROP, Inspector of Schools, Ceylon.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see the Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

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Scientific names and titles of books are printed in italics and personal names in capitals